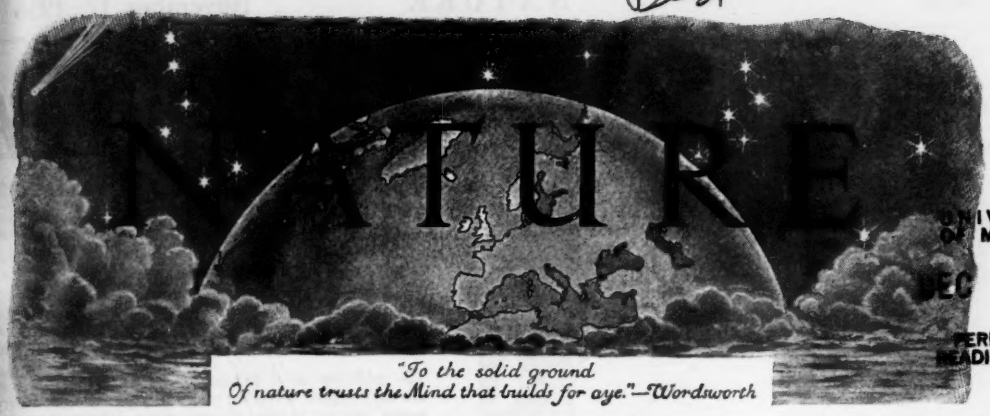
Desk

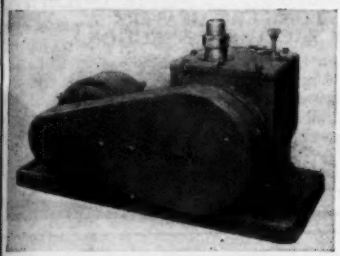


UNIVERSITY OF MICHIGAN
DEC 4 1956
PERIODICAL READING ROOM

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

VOL. 178, No. 4542 SATURDAY, NOVEMBER 17, 1956 TWO SHILLINGS

METROVAC
ROTARY VACUUM PUMPS



Illustrated is the Type S59 rotary vacuum pump.

Displacement: 5.9 litres/sec.

Please write for details of other models in our range.

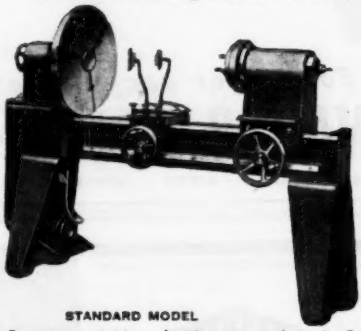
S59

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER 17

Member of the A.E.I. group of Companies

OVER THIRTY YEARS EXPERIENCE IN THE HIGH VACUUM FIELD N/P602

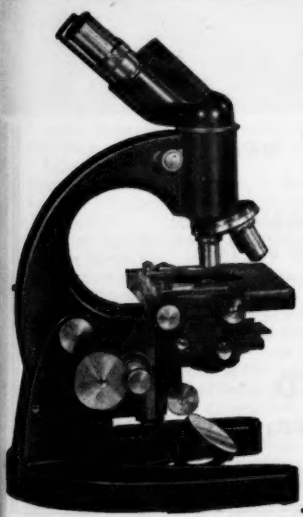
HEATHWAY GLASSWORKING LATHES
are known throughout the world



STANDARD MODEL

★ 5 types available. ★ May we send you leaflets?

HEATHWAY MACHINERY CO. LTD.
UXBRIDGE ROAD, HILLINGDON, MIDDLESEX
TELEPHONE: UXBRIDGE 6345

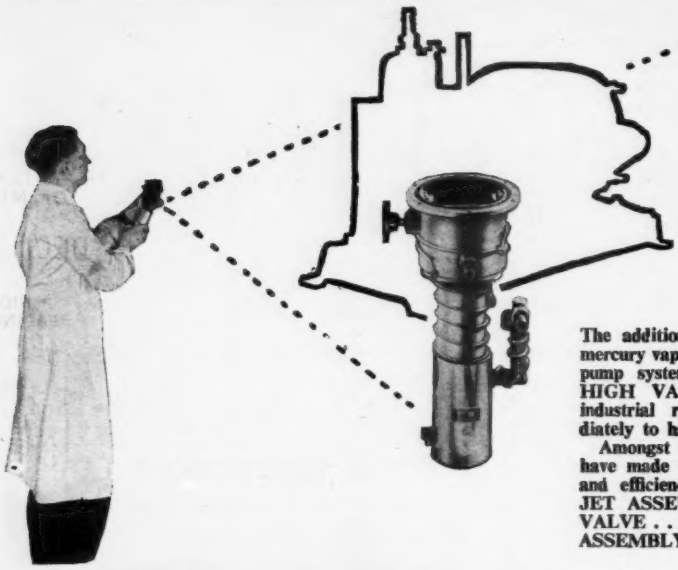


It's the ease of manipulation that counts . . .

. . . allied, of course, with first-class optical equipment. The Baker Series 4 Microscope, with its close-coupled controls placed in a natural position and recently re-designed for even greater efficiency, its new quick-change condenser carriers, and its excellent workmanship and finish, is an instrument with which you will be proud to work. Write now for new illustrated catalogue of this model:

C. Baker
OF HOLBORN LTD. EST 1765

Metron Works · Purley Way · Croydon · Surrey (Croydon 3845-6-7)
Showrooms: 244 High Holborn · London · WC1



Multiply

THE CAPACITY OF YOUR ROTARY PUMP

The addition of a miniature 'SPEEDIVAC' oil or mercury vapour diffusion pump to your existing rotary pump system brings the enormous advantages of a HIGH VACUUM system—an invaluable aid to industrial research and pilot plant work—immediately to hand.

Amongst the many constructional features which have made these little pumps famous for reliability and efficiency are the MULTI-STAGE VAPOUR JET ASSEMBLIES . . . BAFFLE ISOLATION VALVE . . . LONG-LIFE HEATERS . . . RAPID-ASSEMBLY VACUUM CONNECTIONS.

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY

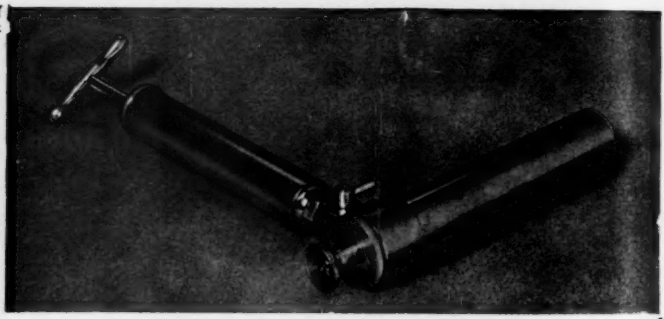
CASELLA LONDON

JET DUST COUNTER

Snap samples can be taken with great rapidity — a quick means of estimating the concentration of airborne dust particles at various points in a mine, factory, etc.

Complete in fitted case.

Available for immediate delivery —write for further details to:



8 × 10·5 in. 3 lb. 4 oz. (20 × 26·5 cm. 1·5 kg.)

Multiple records on a 0·74 in. cover glass

C. F. CASELLA & CO. LTD.

Regent House, Fitzroy Square, London, W.1

Telephone: ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Great Britain

NATURE

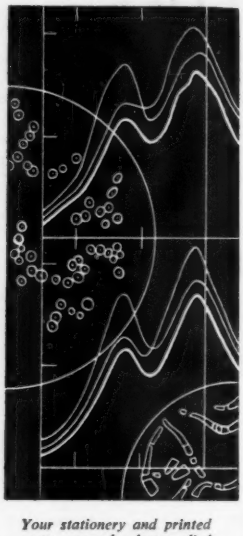
No. 4542 SATURDAY, NOVEMBER 17, 1956 Vol. 178

CONTENTS

	Page
Development of the Peaceful Uses of Atomic Energy	1079
Correspondence of Lavoisier. By Sir Harold Hartley, K.C.V.O., C.B.E., F.R.S.	1081
The Rothschild Collection of Fleas. By G. P. Holland	1082
The Host Parasite Relationship. By Dr. J. N. Oldham	1082
Ionized Gas in Physics and in Astronomy. By Prof. Zdeněk Kopal	1083
The Transition from Classical to Modern Physics. By Prof. R. W. Ditchburn	1083
Wood Structure. By Dr. C. B. Metcalfe	1084
Rock Magnetism. By Dr. J. A. Clegg	1085
The Chemical Research Laboratory	1087
Pomological Research in Poland. By L. C. Luckwill	1089
Dislocations and the Mechanical Properties of Crystals. By Dr. A. H. Cottrell, F.R.S.	1090
Obituaries :	
Mr. H. N. Ridley, C.M.G., F.R.S. By Prof. R. E. Holttum	1092
Prof. Doris L. Mackinnon. By Dr. Ben Dawes	1093
News and Views	1094
Paper-making Apparatus at the Manchester College of Technology. By F. L. Hudson	1098
Agricultural Policies in Europe and North America	1098
Sixth International Congress of Soil Science. By Prof. N. R. Dhar	1099
United Nations Technical Assistance Programmes	1100
India's Contribution to the History of Medicine. By Dr. Douglas Guthrie	1101
The Myxophyceae and Chlorophyceae of New Zealand. By Dr. Kathleen M. Drew	1102
Agricultural Research at the Sudan Central Rainlands Station, 1952–56. By Dr. A. H. Bunting	1103
Marine Fish Fauna of the Gold Coast. By Dr. E. A. Salzen	1105
Modifications of Microscopic Tissue Reactions to Homologous Grafts in Rabbit Parabionts. By Dr. Richard H. Andresen, Dr. Clarence W. Monroe, Dorothy A. Madden and Dr. George M. Hass	1106
Method of Molecular Fields. By T. M. Dunn	1108
Letters to the Editors :	
A Microchemical Method for the Preparation of Sources of Actinium and Europium for β-Ray Spectroscopy.—S. Bjørnholm, O. B. Nielsen and R. K. Sheline	1110
High-Resolution Microwave Zeeman Spectrometer.—R. W. R. Hoisington, C. Kellner and M. J. Pentz	1111
Combustion of Methane.—Dr. Elwyn Jones	1112
Use of Irradiated Polymers as Initiators of Polymerizations.—Dr. J. C. Bevington and D. E. Eaves	1112
Water Sealing of Detached Aluminium Oxide Anodic Film.—Dr. Roy C. Spooner	1113
Torsional Vibrations of Rotating Shafts.—H. Catling and A. E. De Barr	1114
Aluminium Molybdate and its Formation in Clay Minerals.—Dr. L. H. P. Jones and Dr. Angela A. Milne	1115
A Randomly Interstratified Kaolin–Montmorillonite in Acid Clay Deposits in Japan.—Toshio Sudo and Hisato Hayashi	1115
Sensitivity to Ultra-violet Light of Infectious Tobacco Mosaic Virus Nucleic Acid.—Albert Siegel, S. G. Wildman and William Ginoza	1117
Enzymic Oxidation of Glyceric Acid.—Prof. Frank Dickens, F.R.S., and D. H. Williamson	1118
An Apparent Anomaly in the Distribution of Radioiodinated Serum Albumin when added to Red Cell Suspensions.—Dr. Eric Ponder and Ruth V. Ponder	1118
Effect of Thyroxine on the Swelling of Mitochondria isolated from Various Tissues of the Rat.—D. F. Tapley and C. Cooper	1119
Amœbicidal Action of Azaserine.—Dr. Mitsuru Nakamura	1119
Riboflavin in Milk.—V. V. Modi and E. C. Owen	1120
Nuclear Behaviour in Migrating Cells of the Rat's Corneal Epithelium.—Dr. Johanna C. Heerema	1121
Influence of Atropine and Morphine on the Liberation of Actylcholine from the Guinea Pig's Intestine.—Dr. W. Schaumann	1121
Incorporation of Methionine (Sulphur-35) into the Central Nervous System.—J. Fischer, J. Kolousek and Z. Lodin	1122
Possible Interaction of Anti-diuretic and Sodium-retaining Hormones in the Kidney.—Dr. D. F. Cole and J. F. Meredith	1123
Effect of Fast Neutrons on Different Stages of Spermiogenesis in *Drosophila melanogaster*.—Prof. K. G. Lüning and Sten Jonsson	1123
Production of Heteroploidy in the Three-Spined Stickleback, *Gasterosteus aculeatus* (L.).—Dr. H. Swarup	1124
Further Observations on the Blood Factor Dia.—Marion Lewis, Dr. Bruce Chown and Hiroko Kaita	1125
Bacteriological Studies of 'Infected' and 'Uninfected' Chicks in Relation to Antibiotic Growth Stimulation.—M. Lev, Dr. C. A. E. Briggs and Marie E. Coates	1125
Linkage Group XIV of the House Mouse.—J. W. B. King	1126
A Rare Estuarine Copepod Crustacean, *Enhydrosoma garienis*, found in the Holocene of Kent.—J. P. Harding	1127
Flowering Responses of Some Palestinian Legumes to Photoperiod and Temperature.—N. Landau	1128
Anthracnose Fungi of Olives.—G. J. M. A. Gorter	1129
Ætiology of European Foul Brood ; a Disease of the Larval Honey-bee.—L. Bailey	1130
Intrafollicular Cleavage of Human Ovum.—Prof. Landrum B. Shettles	1131
Filaments of Silica.—B. E. Vassiliou	1131
Use of Plastic Tubing in Chromatography.—H. G. Vevers and Prof. N. Millott	1132
Causes of Eskimo Birth-rate Increase.—Dr. Vilhjalmur Stefansson	1132
"Automation Economics."—Dr. Paul Einzig	1132

BOOKS ON SPECIALIZED SUBJECTS

Books on science, research, electronics, industrial work, electrical and mechanical engineering can be quickly supplied through your local Smith's shop or bookstall. College and works librarians and students, particularly, are invited to ask for lists of books on any subject. Any books not stocked locally will be quickly obtained from Head Office.



Your stationery and printed matter can also be supplied through our local branch.

W. H. SMITH & SON

FOR SCIENTIFIC BOOKS

Head Office: STRAND HOUSE, LONDON, W.C.2

A STANDARD BOOK

SAMPLING METHODS FOR CENSUSES & SURVEYS

By FRANK YATES, F.R.S.

Head of the Department of Statistics, Rothamsted Experimental Station, and of the Research Statistical Service of the Agricultural Research Council and the Ministry of Agriculture

CONTENTS :—The place of sampling in census work —— Requirements of a good sample —— The structure of various types of sample —— Practical problems arising in the planning of a survey —— Problems arising in the execution and analysis of a survey —— Estimation of the population values —— Estimation of the sampling error —— Efficiency —— Further notes on the critical analysis of survey data —— Miscellaneous developments —— Bibliography —— Index

"This book . . . has an established place as an authoritative manual on the general subject of sampling."—*Nature*

SECOND EDITION—REVISED & ENLARGED
Medium Octavo (6in. × 9in.), xvi+401 pages
Price 42s. net

CHARLES GRIFFIN & COMPANY LTD
Established 1820
42 DRURY LANE LONDON WC2

FERTILE HENS' EGGS

Large or small numbers always available for research or production.

Can supply in non-returnable boxes

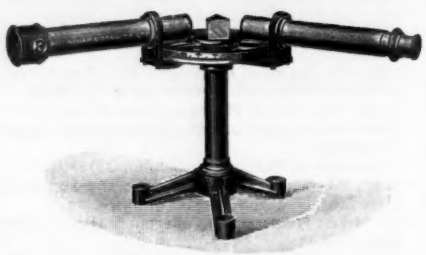
DAY-OLD CHICKS
GROWING PULLETS, COCKERELS AND HENS

supplied for experimental or routine work

N. W. WITHERS
Appleby Farm
EGERTON • ASHFORD • KENT
TELEPHONE: PLUCKLEY 247

PRECISION BS INSTRUMENTS

Simple Type Table Spectrometer



The instrument is supplied at £35 complete with a 60° prism of dense flint glass, and is suitable for use also as a goniometer or refractometer by the 60° method.

If desired a camera, constant deviation prism and Gauss eyepiece can be supplied at extra cost.

Bellingham & Stanley Ltd.

DEPT. N, 71 HORNSEY RISE, LONDON, N.19
PHONE: ARCHWAY 2270

DEVELOPMENT OF THE PEACEFUL USES OF ATOMIC ENERGY

IT is not without significance that the opening by the Queen of Britain's first nuclear power station has almost coincided with the approval by a conference of eighty-two nations of the draft statute for the International Atomic Energy Agency and the election of a preparatory commission of eighteen countries with the task of bringing the Agency into being. This preparatory commission is expected to meet, probably in Europe, early next year, and it is hoped the International Agency, the headquarters of which are to be in Vienna, will come into being by the end of 1957. The Commission will consist of Australia, Belgium, Brazil, Britain, Canada, Czechoslovakia, France, India, Portugal, South Africa, the U.S.S.R. and the United States, together with Argentina, Japan, Egypt, Peru, Indonesia and Pakistan, elected on October 23; and the draft statute now approved empowers the board of governors of the Agency to send inspectors into recipient countries to ensure that neither fissionable materials supplied to such countries nor the by-products of such materials are used for military purposes. The Agency is also empowered to require the recipient countries either to apply such by-products to peaceful purposes or re-deposit them with the International Atomic Energy Agency.

This compromise was adopted after the United States and India had withdrawn conflicting proposals for inspection. The former had sought to ensure that all by-products of fissionable materials furnished by the Agency should be open to complete inspection, while the latter held that such controls were too sweeping and would interfere with the internal economy of recipient countries. In its amended form, this controversial Article 12 is intended to prevent building up of stocks of by-products for purposes not approved by the Agency, and while Sir Alec Randall, speaking on behalf of Australia, Canada, New Zealand and South Africa as well as Britain, could with justice claim that the agreement reached on the safeguarding provisions is a happy augury for the future of the Agency, it remains to be seen how far in practice the sensitive nationalism of Eastern countries, and especially the under-developed countries, will accept the restraints on sovereignty that are inescapable in any effective scheme of international co-operation.

What is most important at the moment is that the way is now open for world co-operation in the use of nuclear energy for constructive purposes on the lines first suggested by President Eisenhower in his message to the United Nations in December 1953. When all allowance is made for the stimulus provided by the conference at Geneva in August 1955, much of the credit for the success of this, the most representative international conference ever held, must be given to its president, Señor Muniz, of Brazil, whose skilful guidance contributed largely to overcoming political obstacles and reconciling conflicting views. The way to co-operation is clear at the very moment when the opening of the Calder Hall nuclear power station in Britain has given emphatic demonstration to the world that nuclear power can be generated on the scale on which electricity is normally generated.

Calder Hall is indeed something more than a milestone in the industrial history of Britain. The most impressive fact about Calder Hall is its size—the demonstration that nuclear power has arrived on a big scale and to stay. Mr. R. A. Butler, who deputized at the opening for Lord Salisbury, the Minister responsible for nuclear energy, remarked that the time when no power stations burning coal will be built is much nearer than had previously been thought. He suggested that soon after 1965 all the power stations built in Britain would be nuclear, and that by 1975 the output of electricity from nuclear power stations would exceed and might double that from all the power stations which supply our needs to-day. This means that in twenty years time, nuclear power will be doing the work of more than 40 million tons of coal a year and possibly of 80 million tons, and the theme of his short speech was in fact that nuclear energy has added a new dimension to our natural resources. The Atomic Energy Authority and all those associated with the Calder Hall venture have every right to be proud of an achievement which puts within our reach in the next twenty years something like a 50 per cent increase in the energy resources we at present derive from coal. It represents the culmination of a venture in which calculated risks were boldly and successfully taken, an effective compromise between what is scientifically desirable and what is physically possible with the methods and materials immediately available; and it has put Britain years ahead of the only other two countries yet within striking distance of making commercial amounts of power from uranium.

Sir Edwin Plowden justly remarked at the opening ceremony that we saw in it the birth of a new industry which, if we follow up our first success with vigour and determination, will assure both Britain and the world of a source of power which will be inexhaustible for generations to come. Our more pressing anxieties about the extra coal supplies which increasing productivity demands have been relieved, and while there is no early prospect of a fall in the price of electricity, there is at least a chance that its price may fall relative to the prices of other fuels and industrial materials. It is clear that nuclear generating capacity could easily approach 4 million kilowatts in 1965 and even 5 million kilowatts, or 15 per cent of Britain's generating capacity if all the fifteen stations projected were built. Mr. Butler's statement, in fact, indicates that the Government's programme for nuclear power will be accelerated, and industry has already submitted tenders for reactors of 300,000 kilowatts and could design them for 400,000 kilowatts, or double the capacity for which approval was given in July for the first two nuclear power stations for the Central Electricity Authority, at Bradwell-on-Sea and Berkeley.

It was the Queen herself, however, who emphasized the way in which this demonstration of the possibility of producing industrial power on a large scale from uranium is linked to the work of the international conference which has since met in New York. "Above all," said Her Majesty, "we have something new to offer to the people of the undeveloped and less fortunate areas of the world, who will continue to look to us for assistance and example as they have done in the past. This to me is the real importance of to-day's ceremony."

The urgent need is for some arrangement whereby the technical skill of Britain and those other nations within reasonable distance of producing nuclear power on a commercial scale can be made available to those less fortunate nations; but it still remains to be seen how widely the new statute will be ratified by governments, and in particular how ready the smaller and undeveloped countries will be to accept the provisions of Article 12 of the statute. It cannot be forgotten that unilateral repudiation of international agreements has seriously damaged the mutual confidence in which alone technical assistance and economic aid from the more advanced to the under-developed countries are possible. The safeguards imposed by that article and the limitations on national sovereignty implied in it have become the more essential and reasonable; yet at the same time, in many parts of the world where nuclear power offers the greatest possibilities of benefit to human welfare, the growth of nationalism has made those countries more impatient and suspicious of restraint.

The benefits of nuclear energy to mankind will be long postponed, however, unless nations are willing to pay the price and accept those limitations on national sovereignty which are a pre-condition of the co-operation that is needed. In Britain we have still to solve the problem of the right balance of scientific and technical effort between nuclear power development and those other technological developments that are necessary to enable Britain to maintain her place in the world's markets. Sir John Cockcroft last April put the number of scientists and technologists working on nuclear power development as about a thousand; but the recent report on scientific and engineering man-power in Great Britain gives the number of scientists and engineers employed by the Atomic Energy Authority this spring at nearly 2,500 and forecasts that some 3,200 will be required by 1959—perhaps one-fifth of those already working for the Atomic Energy Commission of the United States.

These figures are not large, in view of the total of 135,000 scientists and engineers estimated as now available in Britain, or 150,000 forecast as required in 1959; but they could easily represent an excessive proportion of particular categories of scientists or technologists. Moreover, they do not take account of those engaged on nuclear energy projects outside the Atomic Energy Authority or of those required abroad. It is essential if Britain is to reap the full advantage of the Calder Hall achievement that she should be able to provide other countries with the skilled man-power that they will need unless they are prepared to embark on expensive development work for themselves. As Prof. E. W. Titterton emphasized in his recent book, "Facing the Atomic Future", it is expected that these new developments will lead to Britain exporting nuclear power stations on a large scale, in addition to the export trade already developed in radioactive isotopes and fulfilling her traditional role as an exporter of skill. An export trade for the British nuclear energy authority of at least £300 million by 1975 with a home trade at a similar figure is believed to be possible. While the technical aspects of such developments are primarily a matter for the industry itself, the Government should be thinking of the possible repercussions on our economy and our balance of man-power, and of the creation of the conditions most favourable to such an export trade, whether it is to the under-developed areas or elsewhere.

There are two points to be noted here. First, it has been suggested that for the present Britain can best contribute to the development of nuclear energy elsewhere by exporting skill rather than the actual plant—either the full-scale power plant or the 'package' reactors which are likely to be best suited to the needs of many of the under-developed areas. This would make smaller demands on our resources of trained man-power, and it is also an essential preliminary if many areas lacking indigenous fuels and water-power are to operate such plants successfully. Technical assistance is an essential factor for the full exploitation of the export possibilities, and Mr. Butler's speech at Calder Hall gave perhaps the first hint that the Government is really alive to these possibilities. The changes in the organization of the Oversea Civil Service respecting officers with exceptional administrative or professional qualifications announced in the White Paper last May are a step in the right direction, but something much bolder and more imaginative is also required.

The decision as to the proportion of trained man-power and resources Britain can afford to put into the development of nuclear energy may well be one of the most critical that faces the Government in the immediate future. The establishment of the political and economic conditions most favourable to such an export trade in this field, either through technical assistance or through the new International Atomic Energy Agency, is one of its most important political tasks. The Agency, it should be remembered, is not intended to be a charitable institution, although it will be necessary for some means of providing the necessary finance to be found to make possible the building of nuclear power stations in places where they are most needed. It cannot yet be said that the under-developed countries—which are usually also impoverished—will accept the safeguards laid down in the statute creating the Agency, safeguards which while designed primarily to prevent abuse bear closely also on the question of confidence which is essential to attract the necessary financial assistance.

If the statement is ratified widely, the Agency may well hasten the day when the under-developed countries will gain some benefit from nuclear energy; but international confidence and goodwill must first be established. Calder Hall should remind us how great is Britain's interest in maintaining peace and

in fostering international confidence; and in that respect the Government has its primary responsibility in regard to the new export trade to which we may now look, quite apart from the humanitarian aspect to which the Queen referred. Here it might well be wise for the Government to be more forthcoming in regard to co-operation with the European Atomic Agency, and the fact that agreement has been reached at New York in regard to this vexed question of supervision may perhaps stimulate a fresh effort to deal successfully with that problem in Europe. At least it appears to be more doubtful whether Britain can afford to remain outside, even if to participate fully involves accepting a degree of control over the civil and military uses of nuclear energy which infringes national sovereignty more than we would wish, and, more important, could even impede our internal development and exploitation of nuclear power, as Sir George Thomson notes, at least in respect of the Euratom proposals, in his article on Britain's drive for atomic power in *Foreign Affairs* for October. Risks have to be taken, and Calder Hall is first and foremost the vindication of a policy of calculated risks, imaginatively conceived and boldly taken. The fruits of such an achievement will be reaped in no lesser way. The first task in the present troubled world is the restoration of international confidence. This is principally a duty of statesmen and politicians, though scientists can play their part by demonstrating, as they have already done in organizing the project for the International Geophysical Year, that co-operation is still possible in certain fields of activity among the nations.

CORRESPONDENCE OF LAVOISIER

Oeuvres de Lavoisier

Correspondance. Par René Fric. Fascicule 1: 1763–1769. Pp. xviii+252. (Paris: Éditions Albin Michel, 1955.) 2,750 francs or 8.5 dollars.

THE appearance of the first part of the seventh volume of Lavoisier's collected works marks, we hope, the beginning of the last phase in the publication of the literary remains of this many-sided genius. The first four volumes, containing his contribution to chemistry and physics, appeared during 1862–66 under the editorship of Dumas; Volumes 5 and 6, containing his work in geology, meteorology, agriculture, economics and education, were edited by Grimaux during 1894–95; and now comes the beginning of the seventh volume, containing his correspondence between the years 1762 and 1769, collected and edited with scholarly care by M. René Fric and published under the ægis of the Paris Academy of Sciences, helped by a grant from Unesco.

Lavoisier was born in 1743. His mother died in 1748, when his father then went to live with his mother-in-law, and Lavoisier's aunt, Mlle. Punctis, devoted her life to her nephew and his sister. In 1760 Lavoisier went to the Mazarin College, where he had distinguished teachers in the sciences, including the chemist Rouelle. His interests turned first to geology and for three years he assisted Guettard, the foremost geologist of France, in his researches. In 1767 he went on a geological tour in Alsace and Lorraine with Guettard, to collect material for the first geological survey of France. The first half of this volume consists mainly of the correspondence between Lavoisier and his father and aunt during this journey, which lasted four months. They travelled on horseback with an old family servant who carried Lavoisier's barometer and scientific instruments. Lavoisier's letters give a lively description of the incidents of the journey, the progress of his work, and the scientific people they met. The letters from his father and aunt kept him in touch with the life of the family, and reveal their anxiety about the safety of the young traveller and the affectionate home-circle in which they all lived. Travel in France was not without its dangers in those days; but the journey was successful in its object, and Geikie in "The Founders of Geology" speaks of the great promise shown by Lavoisier in his early geological papers.

One of his occupations on the journey was the analysis of the mineral waters in each locality they visited; this and the analysis of minerals first turned Lavoisier's attention to chemistry. His papers were already attracting notice, and the correspondence in 1768 includes letters of congratulation on his election to the Academy at the early age of twenty-five. In the same year Lavoisier joined the Tax Farm, a step which was to have such a tragic ending. The King's Farmers General in France enjoyed the privilege of collecting the indirect taxes on salt and tobacco and certain dues by paying in advance an agreed sum to the Treasury once a year, so that the profitability of their investment depended on the skill of their administration. Lavoisier became an assistant to his future father-in-law, Paulze, and the second half of the volume consists almost entirely of Lavoisier's reports of his work in supervising the collection of the duty on tobacco in the district between Chalons and Lille. The letters describe Lavoisier's daily work and the great care he devoted to his tasks. They show, too, his firm grasp of the administrative problems involved in checking the purchases, the manufacture and the sales of tobacco. Lavoisier makes suggestions for improving the routine of inspection, he sends shrewd comments on the character and ability of the officers, and he devotes much care to the analysis of samples of tobacco to detect adulteration. It was the irony of fate that the chief crime of which he was accused during the Terror was the adulteration of tobacco by increasing its moisture content.

The letters give a revealing picture of Lavoisier as a young man just embarking on his career as a scientist and administrator, and they whet one's appetite for a sight of the next section, which will cover the period when his classic researches on combustion were beginning.

The possibility of continued publication of the remaining volumes must depend partly on the support they receive, and it is to be hoped that nothing will delay their publication. It is confidently expected that the second part of Vol. 1 will appear early in 1957. M. Fric has also traced the missing volume of Lavoisier's laboratory note-books, so that the set is now complete and ready for printing. The extracts published by Berthelot in "La Révolution Chimique" show the intense interest of these daily records of Lavoisier's work. Their publication would throw much fresh light on what was probably the most decisive event in the history of chemistry.

HAROLD HARTLEY

THE ROTHSCHILD COLLECTION OF FLEAS

An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History)

By G. H. E. Hopkins and Miriam Rothschild. Vol. 2: Coptopsyllidae, Vermipsyllidae, Stephanocircidae, [Macropsyllidae], Ischnopsyllidae, Hypsophthalmidae and Xiphiopsyllidae. Pp. xi+445+32 plates. (London: British Museum (Natural History), 1956.) 6 guineas.

THE first volume of this great work, covering the Pulicoidea, was published in 1953 and a review appeared in *Nature* (173, 1203; 1954). The second volume covers seven (of fifteen) families of the Ceratophylloidea. Most of these families are small, and some may be termed obscure. With one or two exceptions, the families are not especially closely related; their treatment together is therefore largely artificial and has the undesirable feature that their closer relatives will be dealt with sporadically in the remaining volumes of the series. The authors are aware of this defect; but their grouping was dictated by practical considerations. Only three of the families treated are represented in the north temperate parts of the world; of these the Ischnopsyllidae are world-wide in distribution; the Vermipsyllidae, Nearctic and Palæarctic; and the small family Coptopsyllidae, restricted to the Mediterranean and Siberian subregions of the Old World. Xiphiopsyllidae and Hypsophthalmidae are Ethiopian, and Macropsyllidae and Stephanocircidae are Australian, the latter also being well represented in South America. The Coptopsyllidae (one genus and nine species or subspecies) are parasites of gerbilles; the Vermipsyllidae (three and twenty-nine), of ungulates and carnivores; Stephanocircidae (eight and twenty-eight), of marsupials, rodents, and perhaps shrews; Macropsyllidae (two and two), apparently of rodents; Ischnopsyllidae (fifteen and seventy-six), exclusively of bats; Hypsophthalmidae (seven and twenty-six), of rodents and insectivores; and Xiphiopsyllidae (one and four), of rodents.

The introductory sections of the book contain much material that is virtually repeated from Vol. 1. However, these sections, including the phylogenetic 'tree' and lists of genera and subgenera, have been corrected and supplemented to bring them up to date. Much of the glossary of technical terminology is repeated, too; but the definitions and illustrations apply especially to the large superfamily Ceratophylloidea, whereas the glossary of the previous volume emphasized the Pulicoidea. The key to superfamilies, families, and subfamilies of fleas is also repeated, but is provided with illustrations that greatly increase its usefulness.

The general plan of the volume is similar to that of the preceding one; superfamilies, families, subfamilies, and genera are fully defined, but species and subspecies must be determined by use of the keys and illustrations, which are, however, adequate for the purpose. Citations are given for original descriptions and important subsequent publications, and complete records of specimens in the Collection are provided. If satisfactory published illustrations were available, they have been reproduced; in other cases new figures of high quality have been prepared by F. G. A. M. Smit and Arthur Smith. The generosity of the authors and the publishers in the matter of illustrations may be appreciated when one considers that 707 drawings and 193 excellent photographs (mostly by Arthur Barron) are provided to illustrate a volume dealing with only 174 species and subspecies.

Although primarily a catalogue of the Rothschild flea collection, the finished work will treat all described species and therefore will virtually constitute a monograph of the fleas of the world. Typographical and other errors in the present volume appear to be few; unfortunately, reference to the Macropsyllidae was omitted from the title page. The book is authoritatively written, lavishly illustrated, and beautifully printed and bound. Like its predecessor, it is a credit to the authors and the publishers.

G. P. Holland

THE HOST–PARASITE RELATIONSHIP

Parasites and Parasitism

By Prof. Thomas W. M. Cameron. Pp. xix+322. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1956.) 35*s*. net.

WITH the experience of more than thirty years teaching of parasitology in London, Edinburgh and Quebec, Prof. Cameron has written this book, which is outstanding for the new approach it makes to the subject. It treats parasitism as a natural biological phenomenon and as a branch of ecology and not from the anthropocentric or economic viewpoint because, all too often in the past, parasitism has had its true nature obscured by a concept of disease and has been regarded subjectively rather than objectively. It is not a substitute for texts on medical or veterinary parasitology as it deals with principles rather than with practice.

Because of the many unsuccessful attempts that have been made to formulate an accurate definition of a parasite, the author attempts to present a concept of the organism by considering how it feeds and discusses nutrition and its evolution in an introductory chapter. There follows a general survey of parasites in which representative types from the bacteria, fungi, spirochaetes, protozoa, viruses, rickettsias, coelenterates, helminths, annelids, arthropods, molluscs, and vertebrates are discussed. This is followed by a consideration of the evolution and development of the defence mechanism of the host. The consequences of parasitism are then discussed. The concluding chapters deal with infectious disease, the factors involved in the distribution of parasites, the principles of control of parasites and parasitic diseases, host specificity and the evolution of parasites. There is a list of 156 selected and annotated references and a separate list of some important catalogues and indexes. These are followed by a classification of the parasites mentioned in the text and by an adequate glossary and index. Many of the 115 diagrams throughout the text are used to replace detailed morphological descriptions which, with systematics, have been kept to a minimum mainly for considerations of space. Misprints and errors are, happily, scarce but the following corrections should be noted: *Fasciola* metacercaria excysts in the alimentary tract (p. 89), *Polystoma* (p. 98), *Caryophyllaeus* (p. 105), pine-weevil (p. 137) and *Braula* (p. 180).

Prof. Cameron suggests that, to read and understand his book, a working knowledge of biology in

general is a pre-requisite but not necessarily a knowledge of parasitology. Be that as it may, the reader who already knows something about parasites will get fuller enjoyment from reading this interesting and absorbing account, written in the author's inimitable style, of the various host–parasite relationships. Some parasitologists may not agree with all the author's points of view and may have doubts, misgivings and reservations, which would meet with Prof. Cameron's approval and sympathy, for no one knows better than he how one's personal views depend largely not only upon one's idea of what constitutes parasitism, but also upon one's approach to, and interpretation of, any given 'facts' about parasitic life. J. N. OLDHAM

IONIZED GAS IN PHYSICS AND IN ASTRONOMY

Physics of Fully Ionized Gases

By Lyman Spitzer, Jr. (Interscience Tracts on Physics and Astronomy, No. 3.) Pp. ix+105. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) Paper, 1.75 dollars; hard cover, 3.50 dollars.

THIS slender volume, the third of a series of "Interscience Tracts on Physics and Astronomy", contains a comprehensive and accurate introduction to the study of physical phenomena exhibited by fully ionized gases. Both in electronics and astrophysics the interest in different manifestations of ionized gases has of late been growing; and its urgency has been enhanced by the fact that the behaviour of such gases is likely to be quite different from that of neutral gas of the ordinary kinetic theory. In point of fact, in certain respects it is likely to be simpler; for most quantum-mechanical effects (except, perhaps, for interaction with the radiation field) can legitimately be ignored; and, likewise, the encounters between charged particles in ionized gas become simplified owing to the long-range character of the inverse-square forces involved. Although the basic physical principles are thus simpler than in an ordinary gas, the actual motions of gas particles become more complicated; for the ordinary hydrodynamical equations governing their motion must be coupled with Maxwell's equations. In the presence of a magnetic field this coupling gives rise to a whole class of novel phenomena (hydromagnetics); and even in the absence of such fields the electrical properties of ionized gas admit of motions which have no parallel in neutral gases.

To which of the two fields of science—physics or astronomy—should the present tract be considered to belong? Its subject has, in recent years, become quite *à la mode* among some astrophysicists, who are apt to regard the more thoroughly studied branches of their science as 'worked out', and to whom the vistas opening with the combination of hydrodynamical and Maxwell's equations seem to offer an unlimited ground for practising their physical insight or manipulative skill. Yet the fact remains (which is perhaps not made sufficiently clear by the author of the present book) that the connexion between theories of fully ionized gases and their experimental verification remains still quite tenuous—both in the laboratory (plasma oscillations) and in the study of certain celestial phenomena (sunspots, or magnetic variable stars being the most conspicuous cosmic examples necessitating hydromagnetic treatment for their understanding). Although some observational data are available on certain aspects of these subjects, their discussion has been entirely excluded from the volume under review, and its contents restricted to those topics which may serve for a theoretical understanding of the subject. This deliberate policy may have helped to keep the size of the book within its modest limits; and a restriction to fundamentals will no doubt extend its useful lifetime.

However, the fact that the gap between theoretical foundations and their possible application to practical cases has been left so wide is probably the most serious criticism of the book which can be raised. Some readers may feel that the book does not bring, at times, its subject sufficiently 'down to earth', and its readability leaves occasionally something to be desired; but its accuracy and reliability as a source of theoretical information should be nowhere in doubt. Like its two predecessors already published in the series of these Interscience Tracts, this present book should thus be viewed primarily as a contribution to physical, rather than astronomical, literature. It should, however, be of interest, not only to research students, to whom it is primarily addressed, but also to all physicists and astronomers interested in a gradual merger of two great physical theories—hydrodynamics and electromagnetism—into a single edifice.

ZDENĚK KOPAL

THE TRANSITION FROM CLASSICAL TO MODERN PHYSICS

Modern Physics

By Prof. John C. Slater. Pp. xi+322. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 39*s.* 6*d.*

THIS book describes the development of theoretical physics during the past sixty years. An introductory chapter on the atom in nineteenth-century physics prepares the ground for a chapter on electron theory and relativity and another one on the beginning of quantum theory. The next five chapters are concerned with the development of the Rutherford–Bohr atom in the period 1912–26. Up to this stage Prof. J. C. Slater uses only elementary mathematics (easy algebra and occasionally calculus). When he comes to deal with the wave-mechanics and its applications, partial differential equations and solutions in terms of Legendre polynomials are used, though he still avoids matrix multiplication and general ideas of operators. The final chapter, on nuclear physics and fundamental particles, is almost entirely non-mathematical and is perhaps the most clearly expressed in the whole book. Rather little space (about ten pages) is devoted to the special theory of relativity. The general theory of relativity and modern field theory are not included. The numerous examples given at the ends of the chapters (with solutions at the end of the book) are of a kind very useful to the student of average ability.

The author says, in the preface, that he wished to write a book which would be suitable not only for the professional physicist but also for "students of history, of human thought and of general culture". He therefore restricted the mathematics "to a rather low level"—which is in fact an impossibly high level for most students of history and general culture. I cannot share the author's belief that the general

reader can skip the mathematics and still apprehend the main ideas when so many of the ideas are expressed in mathematical equations. I propose, therefore, to consider the usefulness of this book to physicists and other readers who have some mathematical ability and training.

The teacher of advanced physics to-day never has enough time to deal with all the topics which he feels are important. It is necessary to omit something to make room for new discoveries, and often it is easiest to sacrifice an account of the way in which ideas have developed. The wave-mechanics is presented to the student as a logically complete system—with only a passing reference to earlier theories of atomic physics. Many of the younger university lecturers in physics have been taught in this way, and the sense of continuity with the nineteenth century is lost. Prof. Slater's book is designed to fill this gap, to show how the failures as well as the successes of earlier theories prepared the way for wave-mechanics. His final chapter reveals wave-mechanics apparently completely successful in the world of atoms, molecules and solids and struggling to prepare the way for its successor by its own successes and failures in the world of nuclei and of unstable particles.

The average student for a first degree can with difficulty assimilate the vast meal which is placed before him. It would not be fair to ask him to add this book to his reading list, though an exceptionally good student of this standing might do so. To a graduate who is beginning research or teaching in physics, this book should be very easy reading. It offers him an opportunity to survey his degree course from a new point of view and to learn why and how physical theory has grown into its present form. Those who are old enough to have followed this growth may also be interested to read this systematic account of an exciting period in the history of physical science.

R. W. Ditchburn

WOOD STRUCTURE

The Structure of Wood

By Prof. F. W. Jane. Pp. vii+427. (London: Adam and Charles Black, Ltd., 1956.) 60*s*. net.

ALTHOUGH the average university student of botany devotes no more than a small fraction of his time to the anatomy of the angiosperms and gymnosperms, there has, in recent years, been an increased interest in the study of wood structure. This is because it is being realized more and more that the accurate identification of timbers is impossible without a knowledge of their microscopical structure. For many years the rule-of-thumb methods by which timber merchants were able to recognize the comparatively small number of woods which they normally had to handle proved adequate for their needs, although mistakes were undoubtedly made. Nowadays, however, with more and more timbers coming into use, especially from parts of the world which were not formerly thought of as timber-producing areas, the task of identification is becoming more difficult. Then again, as Prof. Jane points out in the book under review, although it is still possible to recognize many of the common hardwoods with the aid of a hand lens and a sharp knife, the precise identification of softwoods is well-nigh impossible without resort to the compound microscope. Furthermore, it is impossible to understand the physical and working properties of timbers without a knowledge of their structure, while for the study of the molecular structure of the cell walls the electron microscope is now playing its part. For all these reasons there should be a big demand for a reliable modern text-book of wood structure such as this one which Prof. Jane has now produced.

The book is written in such a way that it can be used not only by those with an advanced knowledge of plant anatomy, but also by intelligent readers who can use a microscope and want to learn how to identify timbers, and to know something of the relationships between their properties and structure. It must have been a difficult problem for the author to decide precisely what aspects of such a wide subject he should deal with in a book of just over four hundred pages; but to the reviewer he appears to have made a wide and balanced choice of topics. The approach is along traditional lines, for the various types of cells and tissues of which wood is composed are first described, and it is shown how these are differentiated from the cells of the apical meristem and the cambium, and organized in the mature wood. Not only is the structure of ordinary softwoods and hardwoods described, but also some attention is devoted to trees and lianes that increase in girth by methods which are often thought of as being anomalous, and to the structure of woody monocotyledons, cycads, and tree ferns. The chemical nature and submicroscopical structure of wood are considered in a chapter written in collaboration with Dr. K. Wilson. The last six chapters are concerned with the identification of timbers, not only in a general way; but it is also shown, for example, how the various timbers that pass in the trade under the names of teak, mahogany and walnut may be recognized. The author also discusses the difficult problem of distinguishing between timbers from closely related species of a single genus, with special reference to oaks, ashes, elms and maples. The book ends with an appendix on technique, followed by a selected bibliography and an index.

The numerous excellent photomicrographs, prepared with the help of Mr. R. Brinsden, add considerably to the value of the book. The author, however, stresses the limitations of photomicrographs as a means of portraying the structure of wood, and rightly emphasizes how line drawings can direct attention to certain diagnostic characters more effectively. The numerous ingenious diagrams in the text serve to confirm this point of view.

Prof. Jane has provided us with a welcome addition to the literature of wood technology and he has performed his task very effectively. In reading through the text, however, one cannot fail to note some minor blemishes. For example, it is rather startling to read on p. 32 that a vessel is a conducting "element", and to find on p. 106 the obsolete term vessel "segment" still in use, while in the last line on p. 156 there is an incorrect figure reference. It would also have been helpful to readers if the rather solid masses of text could have been broken up more frequently with additional headings and subheadings. Small defects such as these will, however, no doubt be corrected in future editions. It is to be hoped that the book will be used not only by students of wood technology, but also that it may serve to remind all students of botany that a good understanding of plant structure lies at the very heart, and not, as so many are apt to believe, at the fringe of their subject.

C. R. Metcalfe

ROCK MAGNETISM

At a meeting of Section A of the British Association on September 4, Prof. P. M. S. Blackett opened a discussion on "Rock Magnetism" by giving a brief account of the history and the present state of the subject. He pointed out that although it has been known for the past hundred years that certain rocks, when formed, acquire a weak but definite magnetism in the direction of the Earth's field, it is only recently that this fact has been used for deducing two types of information of the highest scientific importance: first, to trace back for many millions of years the history of the direction and intensity of the geomagnetic field; and secondly, to attempt to settle the old and acute controversy as to whether the continents have always occupied the same positions relative to one another and to the geographical poles.

Discussing the first of these two aspects of palæomagnetism, Prof. Blackett said that his interest in the subject was originally aroused by the work of Johnson, Murphy and Torreson[1] in the United States, who, in 1948, examined the remanent magnetization of a series of varved clays of New England. These clays were laid down in stream beds, and contain small quantities of detrital magnetic material in the form of fine grains, which were oriented along the Earth's magnetic field at the time of deposition. By measuring changes in the direction and intensity of magnetization with depth, over a continuous vertical sequence, it was possible to trace the history of the geomagnetic field over a period extending back to 15,000 B.C. The results showed that during the whole of this time it has undergone regular variations in direction about geographic north. More recent investigations have confirmed this view, and it now appears that for at least several million years the main Earth's field has corresponded on the average to that which would be produced by an axial magnetic dipole situated at the centre of the Earth; but that there has been a continuous secular variation about the mean direction, with a time period of 500–1,000 years.

Of the greatest importance was the discovery by Brunhes[2] in 1906 that certain lavas from the Massif Central mountain system in France are magnetized in a direction opposite to that of the Earth's field. Many other examples of reverse magnetization in Tertiary igneous rocks have since been discovered, notably by Bruckshaw and Robertson[3] in Britain, by Roche[4] in France, and by Hespers[5] in Iceland, and more recently by Campbell and Runcorn (unpublished work) in America. All these workers found that while approximately half the rocks sampled had an average palæomagnetic direction corresponding closely to that of an axial dipole, the remaining half were magnetized in the opposite direction. Roche and Hospers, in particular, considered that their findings could be most plausibly interpreted on the assumption that the Earth's main field has reversed periodically during Tertiary and recent times. They suggested that these reversals must have occurred rather suddenly at intervals of the order of a million years, and that the field intensity in both the opposite directions has been the same. This result, if true, is of extreme importance, and must dominate all future theoretical thinking on the origin of the Earth's magnetism. Many geophysicists, however, regard the hypothesis of the Earth's field reversal with reserve, and Néel[6] has put forward theoretical arguments to show that there are four possible physical mechanisms whereby a rock, in cooling from above its Curie temperature, can acquire a thermo-remanent magnetization in a direction opposite to that of the applied field. The first two of these mechanisms depend on the properties of ferrimagnetic materials, in which the magnetism is associated with two distinct categories of electron, the spins of which are aligned in antiparallel directions. Gorter[7] has recently succeeded in synthesizing a ferrimagnetic material which exhibits magnetic self-reversal in the laboratory, and there is no reason for supposing that such a material may not have been produced naturally in certain rocks. The third and fourth of Néel's mechanisms are based on the supposition that the rock contains two distinct magnetic components with different Curie points, which exist as an intimate mixture of fine grains. When such a rock cools, it is possible in certain circumstances for one component to become magnetized in the reverse field of the other, and for the final direction of magnetization to be opposite to that of the externally applied field. One example of a naturally occurring rock, which exhibits a self-reversing property of this kind in the laboratory, has been found by Nagata[8]. On the other hand, the great majority of reversely magnetized rocks do not exhibit any self-reversing property when tested in the laboratory.

Considering the whole of the evidence at present available, Prof. Blackett thought that while it is very probable that the Earth's field has reversed periodically in the past, this must not be taken as being finally proved.

Turning to the geological aspects of palæomagnetism, Prof. Blackett said that it was realized at least thirty years ago that, by the study of magnetism of rocks, it should be possible to discover whether there has been any relative movement between the continents during past geological ages, as suggested by Wegener[9], du Toit[10] and others. For, by measuring the present direction of magnetization of a system of rocks, it is possible to deduce both the latitude and the orientation relative to the Earth's rotational axis at the time when it was laid down.

The first palæomagnetic evidence of past continental land movement was obtained in 1954 by Clegg, Almond and Stubbs[11], who found rocks of the New Red Sandstone system, over a wide area of England, to be consistently magnetized along a north-east to south-west axis with magnetic dips considerably shallower than that of the present Earth's field. This suggests that England has moved northwards from a position near the equator, and has rotated in a clockwise sense relative to the poles, at some time since the rocks were formed about 150 million years ago. During the past two years, there have been many more startling results from various parts of the world. It now looks as though the land masses of the northern hemisphere have moved collectively some 40° northward from the equator, while both India and South Africa appear to have been much nearer to the South Pole several hundred million years ago.

These substantial changes in latitude may have been attended by a relative drift between the continents as required by the continental drift hypothesis, or they may represent a movement of the crust as a rigid whole across the poles—often called polar wandering. At present it seems as though relative drift has occurred, but the experimental observations are very incomplete. It should be possible, by piecing together evidence from rocks of all ages and lands, to resolve this question during the next few years.

Dr. A. E. M. Nairn gave an account of the work carried out by members of the group working for the past five years under Prof. S. K. Runcorn, first at Cambridge and later at King's College, Newcastle upon Tyne. Rocks have been collected from almost every geological formation in Great Britain, and from many formations in North America, Europe and South Africa.

Speaking of the evidence for polar wandering and continental drift, Dr. Nairn said that the results of palæomagnetic measurements on rocks of a particular locality and geological period are best expressed in terms of the pole position, which is calculated on the assumption that the direction of magnetization corresponds on the average to that of the axial dipole field at the time of deposition. The pole position obtained in this way represents the mean of many measurements, and its reliability can be expressed in terms of a 'circle of confidence', which is a statistical measure of the dispersion of the results. For a particular rock formation, the dispersion depends on the origin and geological history of the rocks, and it has been found to be least for red sandstones and basic extrusive rocks, so that on the whole the work has tended to be concentrated on these lithological types. Since red sandstones and basic extrusions are rare in the Jurassic, Cretaceous and Ordovician systems, in the northern hemisphere, these periods have not been so well studied as others. From extensive observations accumulated from palæomagnetic measurements in Britain, dating back to the Precambrian, Creer[12] assembled the pole positions in chronological order, and plotted them on a polar projection. He showed that the points can be joined into a continuous curve. Later, Runcorn[13] was able to produce a similar curve based on his and Du Bois's results from North America, which, although similar in form, showed a systematic displacement, the pole positions as calculated from the American measurements lying consistently to the west of the British. Further work has tended to confirm the existence of this discrepancy between the two curves, and there is now strong evidence for the supposition that the American continent has drifted about 2,000 miles westward relative to Europe. This drift seems to have occurred since the late Triassic period, and to have been completed before the end of the Miocene. The extension of the work to continents other than Europe and North America is generally handicapped by the imperfectly known geology; but a series of samples have been obtained from Kenya, Bechuanaland and Rhodesia. These all belong to the Karroo system, which extends in time from the Upper Carboniferous to the Lower Jurassic. The collection of reliable material from surface exposures in this part of the world is rendered difficult by the very deep weathering that has occurred, and the only satisfactory result available so far has been obtained from the Lower Jurassic basalts of the Victoria Falls area. The measurements made on these rocks suggest that the African continent has moved some 2,000 miles with respect to the poles since they were laid down.

The value of an independent check on this palæomagnetic evidence for past continental land movements is obvious, and there are, in the geological record, a number of phenomena such as the occurrence of coal facies, desert sands and red beds, salt deposits, ice ages and tree rings, which depend on climatic conditions, and which can be used for this purpose. The most reliable palæoclimatic data available at present are those obtained from fossil wind directions, which can be found by examination of dune bedding in ancient deserts; for, since the directions of the trade winds are controlled by the Earth's rotation, it is unlikely that their directions could have changed radically during the Earth's history. The subject of fossil winds is being studied at present by N. D. Opdyke at Newcastle upon Tyne and by workers in the United States, and preliminary results for a number of geological periods appear to confirm the pole positions traced for the same epochs from rock magnetic measurements. However, all palæoclimatological evidence does not support the palæomagnetic findings. One particular problem still unsolved concerns the palæomagnetic pole position during the Permo-Carboniferous period, which is situated in China, where, according to palæobotanical evidence, warm conditions prevailed at that time.

Discussing the question of reversals of the Earth's field, Dr. Nairn considered the best evidence of past reversals to be found in the work of Hospers[5], mentioned previously, and that of Irving[14] on the Torridonian sandstones of Scotland.

Dr. J. A. Clegg described palæomagnetic research carried out at the Imperial College of Science and Technology in London, and elsewhere. Discussing the subject of continental drift, he first compared the original measurements made by Clegg, Almond and Stubbs[11] on the British Triassic sandstones, which had been described earlier by Prof. Blackett, with more recent results obtained by Graham[15] for similar Permian and Triassic sandstones in the western United States. The mean directions of magnetization of the British and American rocks correspond respectively to pole positions 155° E., 48° N., and 106° E., 34° N., both lying in eastern Asia. It appears, therefore, that there has been a considerable change in the positions of both these land areas relative to the Earth's rotational axis since Triassic times. The two positions lie approximately 20° apart, and this suggests that there may also have been a relative movement between Britain and North America; but the dispersion of the results and the uncertainties in dating are such that there is grave doubt as to the significance of this discrepancy. After mentioning measurements by Gough[16] on the Pilansberg dyke system of Africa, which indicate that South Africa probably occupied a position on the other side of the south pole some 250 million years ago, Dr. Clegg went on to describe some more recent work being carried out at present by the Imperial College group on lavas of the Deccan Trap system of India[17]. These latter rocks are found to have consistent directions of magnetization corresponding to a position of the north geographical pole close to Florida (85° W., 28° N.), which implies that at the time when they were laid down, some 70–100 million years ago, the Indian subcontinent must have been situated considerably to the south

of the equator. This result is supported by palæoclimatic evidence, for it is well known that during the Permo-Carboniferous period there was heavy glaciation in India, and that the ice was flowing northward.

The Imperial College group has also made palæomagnetic measurements, in collaboration with Prof. J. C. Jaeger at Canberra, on certain Tasmanian Jurassic–Cretaceous dolerites, 100–120 million years old, together with overlying Tertiary basalts. The samples were taken from unoriented diamond-drill cores, so that it was not possible to measure the azimuthal direction of magnetization. However, the magnetic dips proved to be much steeper than that of the present dipole field in Tasmania, the mean directions of magnetization of the dolerites and basalts lying respectively within 5° and 7° of the vertical. This means that some 100 million years ago Tasmania was within 10° of the south pole, and that its latitude remained substantially unchanged at least until early Tertiary times. It is interesting to compare this result with that previously quoted for the Indian rocks of similar age. For, expressed in terms of pole position, it places the north pole close to a point antipodal to Tasmania in the western North Atlantic, at least 2,500 miles from the position obtained for the Deccan Trap measurements. This seems to supply good presumptive evidence of a relative movement between Tasmania and India.

Finally, Dr. Clegg described two experiments carried out on reversely magnetized rocks. The first was concerned with a volcanic tuff from Tasmania, obtained from the same borings as the basalts and the dolerites mentioned previously, but from a greater depth. A single five-foot length of core was examined, and was found to be magnetized, like the overlying dolerite, in an almost vertical direction; but whereas over the major part of its length the magnetic dip was in a normal (upwards) sense, over a single five-inch portion the polarization was reversed. The reversed and normal portions appear to be identical in all respects, and so far no satisfactory explanation of the phenomenon has been found. The result does, however, serve to emphasize the complexity of the problem of interpreting magnetic reversals. The second experiment was carried out by J. H. Leng on three Tertiary dykes from Arran. Two of these dykes, together with the baked sediments in contact with them, were uniformly magnetized in directions close to that of the present Earth's field; but in the third case, both the dyke rocks and the contact sediments had acquired a thermo-remanent magnetization in the reverse direction. Since the magnetic minerals present in the igneous intrusion are very different from those in the surrounding country rocks, it seems unlikely that this reversal of both dyke and contact sediments can be due to a Néel effect. Experiments of this type would appear to provide strong evidence for the hypothesis of the reversal of the Earth's field.

All the speakers emphasized at the meeting their belief that while information of great importance has already been obtained from palæomagnetic studies, the present conclusions must be regarded as purely tentative, and will be subject to continuous modification as the work develops. J. A. CLEGG

[1] Johnson, E. A., Murphy, T., and Torreson, O. W., *Terr. Mag.*, **53**, 349 (1948).
[2] Brunhes, B., *J. de Phys.*, **5**, 705 (1906).
[3] Bruckshaw, J. McG., and Robertson, E. I., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 308 (1949).
[4] Roche, A., thesis, University of Paris (1953); *C.R. Acad. Sci., Paris*, **230**, 113 (1950); **236**, 107 (1953).
[5] Hospers, J., *Proc. Kon. Ned. Akad. Wet.*, B, **56**, 467 (1953); B, **57**, 112 (1954).
[6] Néel, L., *Ann. Geophys.*, **7**, 90 (1951).
[7] Gorter, E. W., thesis, Leyden (1954); *Philips Res. Rep.*, **9**, 295, 321, 403 (1954).
[8] Nagata, T., *Nature*, **172**, 850 (1953).
[9] Wegener, A., "The Origin of Continents and Oceans" (Methuen, London, 1924).
[10] Du Toit, A. L., "Our Wandering Continents" (Oliver and Boyd, London, 1937).
[11] Clegg, J. A., Almond, M., and Stubbs, P. H. S., *Phil. Mag.*, **45**, 583 (1954).
[12] Creer, K., thesis, Cambridge (1954).
[13] Runcorn, S. K., and du Bois, P. M., *Phil. Trans. Roy. Soc.* (in the press).
[14] Irving, E., thesis, Cambridge (1954).
[15] Graham, J. W., *J. Geophys. Res.*, **60**, 329 (1955).
[16] Gough, D. I., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.* (in the press).
[17] Clegg, J. A., Deutsch, E. R., and Griffiths, D. H., *Phil. Mag.*, **1** (viii), 419 (1956).

THE CHEMICAL RESEARCH LABORATORY

THE annual open days of the Chemical Research Laboratory (Department of Scientific and Industrial Research) were held during October 2–5. Some of the exhibits by the six main research groups are described in the following paragraphs.

One laboratory has been reconstructed to house the larger apparatus used in corrosion research. A preparation room is equipped for the surface preparation of specimens, maintenance of testing equipment, and water treatment. A constant-temperature room, of brick and glass-brick construction with double glazing on the windows, is provided with humidity control. Four model boilers, each with six electrically heated tubes giving a heat-transfer rate of 7,000 B.Th.U./59 sq. ft. of tube surface per hour, are used in an investigation on behalf of the British Shipbuilding Research Association. A circulation apparatus for studying corrosion and its prevention in flowing water was in operation. The test solution is pumped from a tank into a header tank and runs back into the lower tank through the test specimens, which are in the form of mild-steel tubes. Non-corrodible stoneware pumps and glass tanks are used, so that the only metal in the circuit is the material under test.

Goods are often protected during storage and transit by enclosure in impervious wrappings. Although such wrappings prevent the entry of corrosive agents from outside, they may aggravate corrosion of the metallic contents by accumulation of relatively reactive compounds evolved from non-metallic components. At the Laboratory, corrosion in radio receivers has been traced to vapours evolved from synthetic resins and glues. Exploratory studies are being made of the corrosive effect of some likely

contaminants in conditions simulating those of an undesiccated package.

The Inorganic Group provided an interesting exhibit on the use of zone-refining for the purification of some of the metals which are of interest as semi-conductors, such as bismuth, indium, tellurium and tin. Etched specimens of bismuth and tin, before and after treatment, provided a striking visible demonstration of the effect of zone-refining. Special studies have been carried out using selected impurities in the form of radioactive tracers. This method not only overcomes the analytical difficulties attendant on such work, but also, with a tracer of relatively long half-life, it enables numerous experiments to be carried out on the same ingot. The use of a cathode-ray polarograph in aiding the analytical side of the research was demonstrated, while the other analytical facilities of the Group—well-equipped spectrographic and microchemical laboratories—also attracted attention. Separation of the rare earths by ion-exchange processes and demonstrations, on the laboratory scale, of separations using the Spedding and the Loriers methods were exhibited. Large ion-exchange columns, and ancillary equipment required for processing kilogram quantities of mixed earths, were in operation. A collection of ores containing the rare earths was on view.

Exhibits in the Radiochemical Laboratory included a small pilot plant for the treatment of uranium-bearing ores. This consists of leaching, continuous filtration and clarification units by which a sulphate liquor containing the uranium dissolved from an ore can be obtained. A further unit enables the uranium to be recovered by adsorption on columns of ion-exchange resin, and finally by precipitation as a concentrate from an eluting solution. The leaching unit was being used for illustrating the possibility of leaching uranium from certain types of ores by adding sulphuric acid in such a manner as to maintain a low but constant acid concentration. A new type of resin-in-pulp apparatus was also on view. This enables uranium to be recovered from a suspension of finely ground ore in dilute acid without the necessity for filtration. It employs a series of semi-continuous belts consisting of sheets of ion-exchange membranes which move counter-currently through the flowing suspension. Part of the work being carried out on the extraction of thorium from minerals was illustrated by the demonstration of a process for obtaining thorium from monazite in which monazite is initially attacked and broken up by reaction with a strong boiling solution of sodium hydroxide. After filtration, sodium phosphate can be removed from the filtrate and thorium from the residue by differential solution with hydrochloric acid. Examples of further advances in the use of modified celluloses for the chromatographic separation of inorganic mixtures were illustrated by exhibits of promising separations of mixtures of the rare earths obtained on sheets of carboxymethyl cellulose.

A colourful exhibit by the Organic Group was the application of a new series of compounds to certain analytical problems. These coloured complexes contain as a common characteristic the pentacyanoferrate radical co-ordinated with an organic molecule. Some, owing to their intense colour, are particularly useful as spray reagents for the qualitative and quantitative detection of inorganic cations in paper chromatography. Thus trisodium pentacyano-*p*-hydroxyanilino ferrate yields blue precipitates insoluble in dilute acetic acid with many cations, and as little as 1 μgm. of the following can be detected: Cu^{2+}, Zn^{2+}, Cd^{2+}, Zr^{4+}, Mn^{2+}, Fe^{3+}, Co^{2+} and Ni^{2+}. Another reagent, prepared by the reaction of trisodium pentacyanoammino-ferrate and rubeanic acid, is especially useful in that it produces distinctive colours with different cations.

The stability of some of these complexes is so influenced by steric and constitutional factors that they can be adapted to the analysis by colorimetric methods of mixtures of certain closely-related organic compounds. Trisodium pentacyanoammino-ferrate develops a red colour with *iso*nicotinic acid, but not with its common congeners, nicotinic and dipicolinic acids, and thus provides a method for determining the purity of *iso*nicotinic acid, which is a substance with important chemotherapeutic applications. Another example shown was the estimation of the proportion of quinoline and *iso*quinoline in a mixture of these bases.

In recent years the use of water triple-point cells for setting up a thermometric fixed point has been well established. An obviously desirable extension of technique would be to use a triple-point cell containing carbon dioxide as a reference point in measurements below 0° C. Such a cell has been constructed in metal and, while strong enough to withstand storage and transport at ordinary temperatures, it enables the triple point of carbon dioxide, −56·60° C., to be reproduced to ±0·002 deg. This cell can be obtained on loan by other workers.

Two other notable exhibits shown by the Organic Group dealt respectively with the preparation and use of finely-divided dispersions of sodium, and the convenience of oxazolidone-2 as a source of ethylene–imine for polymerization and other reactions.

The Microbiology Group illustrated various activities of sulphate-reducing bacteria: their function in the natural production of elemental sulphur in Cyrenaican lakes, the contamination of aviation fuels in storage tanks, and their use in a process for producing sulphur from indigenous raw materials. One exhibit, loaned by Rolls-Royce, Ltd., showed how the grounding of both piston-driven and jet aircraft, through failure of their fuelling system, was traced to petrol or kerosene stored over water which became grossly infected with sulphate-reducing bacteria. The hydrogen sulphide produced by these organisms percolated through the fuel, forming sulphur compounds which caused heavy corrosion of fuel pumps in the aircraft, sometimes after as little as four hours flying time. To prevent future trouble, the use of water bottoms in fuel storage tanks should be avoided. Where this is not possible, a bacterial inhibitor such as chromate should be added to the water. Another exhibit illustrated pilot-plant (50 gallons) trials, carried out at the L.C.C. Northern Outfall Sewage Works, Beckton, of a process devised at the Chemical Research Laboratory for the production of hydrogen sulphide from sewage sludge enriched with calcium sulphate. Results equal to those from laboratory experiments have been obtained, and trials on a much larger scale are contemplated. The National Collection of Industrial Bacteria used illuminated panels for showing pigment production, methods of counting and cultural characteristics of micro-organisms. The Collection distributed more than 1,500 cultures last year.

Work in progress on the fractionation of polymers and on the preparation and properties of ion-exchange membranes was shown in the High Polymers Group. The mechanical and physical properties of many industrially important polymers are dependent on molecular weight; two promising new techniques for determining molecular weight distributions were exhibited. One method consists of fractionating polymers in solution by causing the heterodisperse polymer to diffuse across membranes of varied selectivity. Advantages of this procedure are that the polymer is in true solution throughout the fractionation, and relatively large amounts of material can be treated in apparatus which is much more compact than that used in techniques employing fractional precipitation or dissolution. The other method, primarily of value for low-molecular weight polymers, is a development of the technique of paper-strip chromatography to provide a rapid semi-micro procedure for determining molecular-weight distributions.

Much interest is now being shown in the possible large-scale application of multicompartment electrodialysis cells to the demineralization of brackish water, and to treatment of industrial effluents. The efficient operation of such cells is markedly dependent on the properties of the ion-exchange membranes used, and extensive studies of the preparation and properties of ion-exchange films are in progress at the Laboratory. One exhibit showed the results of a systematic study of membranes prepared by incorporating finely divided ion-exchange resins of different degrees of cross-linkage into an inert polymeric binder.

POMOLOGICAL RESEARCH IN POLAND

By L. C. LUCKWILL

Long Ashton Research Station, University of Bristol

ON May 23 the new buildings of the Polish Research Institute of Pomology at Skierniewice, about forty miles south-west of Warsaw, were officially opened by the Polish Vice-Minister of Agriculture, Mr. Szajer. This event, which marks the beginning of a new era of pomological research in Eastern Europe, was the occasion for a conference attended by Polish research workers and by twenty-four foreign delegates representing thirteen different European countries.

The Research Institute of Pomology was founded in 1951 as part of the post-war plan to co-ordinate pomological research in Poland, which previously had been conducted at many different centres controlled either by the State Agriculture Institute at Puławy or by the agricultural colleges at Warsaw, Lublin, Poznan, Krakow and Wrocław. The Institute is housed in a large three-storied building which, in addition to modern laboratory and library facilities, contains a large conference room, canteen and com-

Fig. 1. Institute of Pomology, Skierniewice, Poland

mon rooms for the staff, living accommodation for visiting workers and a permanent exhibition room containing demonstrations for visiting fruit-growers. Adjacent to the Institute are a number of apartment houses for the staff, and future plans envisage the addition of an extensive block of experimental glass-houses and cold stores. On one side of the building lies the large experimental orchard of the Warsaw College of Agriculture containing demonstration experiments and an important collection of 1,800 species and varieties of cultivated fruits.

Most of the field experiments of the Institute are carried out at field stations situated in the different fruit-growing regions of the country. In all there are eleven such field stations, varying in size from 140 to 1,440 acres, each under the control of a director and small scientific staff, working in close co-operation with the staff of the Institute. The total area available for such field experiments is about 5,800 acres, of which a considerable proportion is at present devoted to extensive variety trials of tree fruits, currants, gooseberries and strawberries. The chief object of these trials is to find high-yielding varieties of good quality that are capable of surviving the extreme cold of the Polish winter. The trials themselves are well laid out and are randomized and replicated to an extent sufficient to satisfy the most fastidious statistician. In addition to these field stations the Institute has also planted many experimental and demonstration orchards on the State farms, and a few on peasants' holdings.

The creation of the Research Institute is due largely to the enterprise and initiative of the present director, Prof. S. A. Pieniążek, who returned to Poland from the United States in 1946. One of his chief difficulties throughout has been the acute shortage of trained scientific workers. At the end of the Second World War there were only four persons with Ph.D. degrees working in pomology in Poland: to-day the number has risen to about twenty, but most of the ninety-nine members of the scientific staff of the Institute are recent graduates with relatively little research experience. A few have received training in Moscow, and almost all have the ambition to work for a time in England in order to broaden their experience or to acquire specialist techniques.

The work of the Research Institute is divided into twelve departments designed to cover most of the problems of importance for fruit growing, such as soil cultivation, fruit breeding, mechanization, plant protection, and fruit technology. Winter killing is undoubtedly the most serious problem confronting fruit growers in Poland, and much research effort is devoted to the study of this problem, particularly to methods of increasing winter hardiness of trees and the selection of cold-resistant varieties. The importance of this problem is shown by the violent fluctuations of the fruit tree population during recent years. It is estimated that in 1939 there were about fifty million fruit trees in Poland. More than half of these were destroyed by cold in the winter of 1939–40, and by the end of the War the population had further decreased to twenty-two million. Extensive post-war plantings, which are still continuing, had raised the number to approximately thirty-five million in 1955; but a further severe winter during 1955–56 again wrought great havoc, particularly among pears and plums, in the orchards of central Poland.

In the Soviet Union, pomological science, under the influence of Michurin, has developed along lines different from those pursued in Western Europe and Scandinavia, and many concepts basic to Russian pomological work (for example, graft hybridization; the 'mentor' theory) are regarded with scepticism by pomologists in other countries, including, incidentally, many in Poland. Soviet pomologists, on the other hand, are equally sceptical of much Western work, particularly that relating to virus diseases in fruit crops and the application of statistical methods to field experiments. Poland, open to cultural influences from both East and West, is bound to neither school of thought, and the present policy of pomological research is to make use of those ideas and techniques that seem most appropriate to the problems in hand, irrespective of their origins. Here, indeed, in a limited field of endeavour, we have a true hybrid between Eastern and Western scientific thought which, though yet young, already manifests the marked vigour characteristic of crosses between widely dissimilar parents.

DISLOCATIONS AND THE MECHANICAL PROPERTIES OF CRYSTALS

DURING September 6–8, about forty metallurgists and physicists from various countries met at Lake Placid, New York, to discuss the mechanical properties of dislocated crystals. The conference was sponsored jointly by the U.S. Office of Scientific Research, Air Research and Development Command and by the General Electric Research Laboratory, Schenectady, and organized by Dr. J. C. Fisher. The discussions were quite informal and their purpose was to assess, in the light of recent work, the extent to which we understand the mechanical effects of dislocations in crystals. A few related questions were also taken up, such as the growth of whisker crystals and the nature of radiation damage.

Comparing this conference with those held in the United Kingdom in 1954, I was struck by two major changes in the subject, both of which were foreseen at the earlier conferences. First, the study of dislocations has now become very definitely an experimentalist's subject. By contrast, the development of dislocation theory has, temporarily at least, almost ceased. The reason for this is fairly clear. The geometrical and elastic theories of single dislocations and of simple arrays of dislocations have now been almost completely worked out, and only the very hard problems of the dynamics of fast-moving dislocations and of the detailed atomic structures in the cores of dislocations remain. But to understand work-hardening, creep, fatigue, fracture and recrystallization, we have to study the collective behaviour of large, complex assemblies of dislocations, and the theory of this can go forward only when experiments have shown what are the decisive aspects of this behaviour in practice.

The second striking change is that the experimentalists are no longer content to look merely at slip lines. Stimulated mainly by the development of etch-pit techniques and by methods of precipitating

atoms on the cores of dislocations, they now insist on seeing the individual dislocations in their specimens. As a result, when they now speak about dislocations gliding and multiplying in slip lines, and climbing out of these lines and polygonizing, they are no longer making theoretical conjectures, but are describing what they have actually seen taking place.

One of the most vivid examples of this was provided by Dr. P. B. Hirsch's motion-picture film of dislocations in aluminium foils observed by transmission electron microscopy. Here we were able to see single dislocations gliding, sometimes slowly, sometimes quickly, along close-packed planes. We saw them bow out under applied stress, interact with each other, reach unstable configurations and then run rapidly into nearby sub-boundaries. We also saw how remarkably effective an applied stress can be in breaking up dislocation nets within the crystal and driving the dislocations into boundaries, a fact often inferred previously from results of creep and recovery experiments, but never before actually seen.

It is pleasing to see how many of the predictions of dislocation theory, made a few years ago, are now being confirmed. The study of dislocation networks in ionic crystals, made visible by the precipitation of metallic atoms on the dislocation lines, has gone forward actively, and Dr. S. Amelinckx and Dr. J. W. Mitchell showed many examples of networks in silver halides, sodium chloride and calcium fluoride, which conformed closely to the patterns expected from considerations of Burgers vectors and elastic stability. Isolated closed dislocation rings and spiral dislocation lines were also seen in the calcium fluoride specimens, so confirming the ideas of Prof. F. Seitz about the condensation of point defects into platelets and on to screw dislocations. We were also shown some beautiful examples of Frank–Read sources in operation in silicon, photographed by Dr. W. C. Dash, using copper atoms to mark the dislocation lines and infra-red light to photograph them.

Drs. J. J. Gilman and W. G. Johnston have developed a versatile etch-pit technique for studying dislocations in lithium fluoride. One type of etchant attacks all types of dislocations in the material, whereas another type attacks only those dislocations that have (presumably) absorbed some impurity during annealing; freshly created dislocations can thus be distinguished from old ones. The symmetry of an etch-pit differs according to whether the dislocation it marks is an edge or a screw, so that these two types of dislocation can be distinguished. When a dislocation is pulled away from its etch-pit, that pit then develops a flat bottom, so that the present and past positions of a dislocation can be identified. Perhaps the most outstanding of the many observations made on lithium fluoride with this technique is that, at a stress of about 1 kgm. mm.$^{-2}$, small dislocation loops can nucleate, grow and multiply into fully active slip bands in apparently perfect regions of the crystal. These intriguing results aroused much discussion. It seems clear that here a complete slip band can be formed independently of a dislocation network. One suggestion, made by Dr. W. M. Lomer, is that parts of an expanding dislocation ring may in fact jump from one slip plane to another, by cross-slip, so that segments of dislocation lines capable of acting as Frank–Read sources may be formed in the neighbouring slip planes. The nature of the primary defects, from which the first loops are nucleated, remains a mystery. Dr. J. C. Fisher suggested that they may be small platelets of condensed vacancies; but so far it has not been possible to reveal them by etching.

Several experiments were described that gave evidence about the location of the original sources of slip in various crystals. Dr. W. T. Read deduced, from an observation that more dislocations are formed when a germanium crystal is bent than would be expected from the theory of plastic bending, that some dislocation sources became operative in the interior of the crystal. In a somewhat similar experiment on an aluminium crystal strained in tension, Prof. B. Chalmers deduced, from the character of X-ray reflexions obtained by the Schultz method, that the dislocations must have moved into the crystal from the surface. Further evidence for slip starting at the surface was presented by Dr. T. Suzuki, who worked with potassium chloride, and the present writer, who described some work of Mr. M. A. Adams on copper. Suzuki showed that birefringent bands first appeared on two opposite faces at the beginning of slip, and that the effect of contaminating these faces with impurity caused the yield stress to increase. Adams showed that a copper crystal normally does not yield discontinuously or strain-age, but that it can be made to do so by introducing 1 per cent of zinc into its surface. These effects, which suggest that slip begins at surface sources, disappear when the zincified layer is removed.

Several examples of impurity yield points were reported; arsenic in copper (Dr. W. Boas) and oxygen in silicon (Dr. W. T. Read) both produce the effect. Dr. K. Lücke described an extensive investigation of the pinning of dislocations by impurity atoms, based on the damping of high-frequency (10^8 c./s.) oscillations. The rates of migration of impurity atoms to dislocations and their binding energies in dislocations were both measured in these experiments; for example, bismuth in lead is bound to dislocations with an energy of 0·11 eV. Dr. W. Boas showed some effects of impurities on the annealing behaviour of cold-worked copper, which Prof. N. F. Mott interpreted in terms of the anchoring of jogs by impurity atoms, so hindering the climb of dislocations. The rate of climb of dislocations was also discussed by Prof. F. R. N. Nabarro in an analysis of the straightening of kinked whisker crystals.

One point which emerged strongly at the conference is that in many materials dislocations glide rather 'stickily', suggesting that they are hindered by a large Peierls–Nabarro force. We saw examples of this in Gilman's work, in which the stress to move visible dislocations varies sensitively with temperature and rate of strain and always remains large even in apparently perfect regions of the crystal; also in silicon, in which the yield stress is very sensitive to temperature even after the impurity yield point has been overcome (W. T. Read), and in which the dislocation lines follow crystallographic directions closely (W. C. Dash) and take up positions in the slip plane which appear to be determined by their rate of glide rather than by their mutual elastic interactions. Gilman showed that fast-moving cracks (more than 10^4 cm. sec.$^{-1}$) do not produce dislocation loops at their tips, whereas slow ones (less than 10^4 cm. sec.$^{-1}$) do. Since large amounts of energy can be dissipated by slip at the tips of cracks, the stickiness or otherwise of dislocations undoubtedly plays a major part in determining the tendency towards brittleness or ductility of crystals. Even in metals, it begins to look as if the Peierls–Nabarro force is small only for slip on close-packed planes. According to Dr. A.

Seeger, the force does not make itself felt in these planes until rather low temperatures (lower than 100° K.) are reached, where the internal friction of the metal rises up to the 'Bordoni peak'. In the face-centred cubic metals, we scarcely ever see slip on planes other than close-packed ones, except possibly at high temperatures; similarly, in close-packed hexagonal metals, only the basal slip system has a flow stress that is insensitive to temperature, and the high sensitivity of other systems to temperature is strongly suggestive of a large Peierls–Nabarro force. It now seems probable that the sensitivity of the yield stress in iron is due at least partly to a large Peierls–Nabarro force, which may help to account partly for some of the observations on delayed yielding in iron that were reported to the conference by Dr. D. S. Wood.

In the discussions of solid-solution hardening and radiation hardening, the point was brought out from the work of Prof. R. W. K. Honeycombe and Dr. T. Blewitt that the yield stress of such materials is quite a sensitive, parabolic, function of temperature. Dr. H. Suzuki offered an explanation of the solid solution case in terms of the impurity yield-point mechanism, and several views were expressed about radiation hardening. Dr. J. Friedel suggested that vacancies agglomerated into large voids along dislocations, Dr. T. Blewitt considered that aggregates of point defects formed in the lattice would produce a type of precipitate hardening, while the present writer explored the possibility that the absorption of point defects by dislocations would cause the latter to climb out of their glide planes and thereby give them a large Peierls–Nabarro force.

The discussions of work-hardening were centred mainly around the nature of the obstacles responsible for work-hardening. Dr. A. Seeger showed that slip dislocations escape from their barriers in the slip planes by undergoing cross-slip and he proposed a variant of the Lomer–Cottrell barrier in which slip dislocations in screw orientation would become locked against barriers formed from two secondary slip systems. Prof. N. F. Mott raised the question of the behaviour of such systems on unloading. It seemed to the writer that the back-stress from its own piled-up group of dislocations could not be the reason why a given dislocation source ceased to act during unidirectional straining; for if this were the case, the stored elastic energy in the system would be nearly equal to the total work done, and most of the plastic strain would be recovered during unloading. The hardening of the Frank–Read sources must originate in some other way, perhaps from the internal stresses due to other nearby dislocation groups, as in the theory suggested a few years ago by Prof. Mott.

The problem of understanding fatigue failure still appears very difficult. The idea that vacancies are formed during the glide of dislocations has met with difficulties, mainly because we are still not sure how dislocations can produce vacancies; in fact, when gliding screw dislocations intersect they are more likely, if they produce any point defects at all, to produce interstitials rather than vacancies. Prof. Mott proposed a new mechanism whereby a gliding screw, oscillating to and fro with the applied stress, jumps cyclically from one plane to another by means of cross-slip at the ends of its path; this causes the material between these planes to be squeezed out of the crystal, leaving behind a void in the slipped region. This ought to be just the type of process that could be examined directly by the new experimental techniques mentioned above.

Interest has grown rapidly in recent years in the mobilities of various types of defects in solids, particularly at very low temperatures. Prof. J. S. Koehler, Dr. T. Blewitt and Dr. W. Boas summarized recent work on the annealing of point defects in quenched, irradiated and cold-worked metals, and Dr. G. Leibfried concluded that zero-point motion may contribute to the mobility of point defects at very low temperatures, but is unlikely to be important in the motion of dislocations because the vibrational modes useful for helping dislocations over barriers have long wave-lengths and low Debye temperatures. Dr. Blewitt showed that copper crystals can be work-hardened in liquid helium up to yield stresses greater than one per cent of the elastic constant, and that at these high stresses it is possible to pull partial dislocations away from one another, so forming stacking faults and deformation twins. Prof. C. S. Barrett described some recent work by Dr. P. Haasen and Dr. A. Kelly which showed that nickel and copper crystals develop yield points after plastic straining, unloading and reloading, in liquid helium, and Dr. Blewitt mentioned that internal friction experiments have shown that dislocations can become pinned as a result of neutron irradiation at 17° K. Certainly, one of the most fascinating developments of the subject in recent years is the discovery of so much evidence for atomic movements in crystals at temperatures of a few degrees above absolute zero.

A. H. Cottrell

OBITUARIES

Mr. H. N. Ridley, C.M.G., F.R.S.

Mr. H. N. Ridley died in his one hundred and first year at his home at 7 Cumberland Road, Kew, on October 24. On the occasion of his hundredth birthday (December 10, 1955), Mr. J. W. Purseglove contributed to *Nature* an appreciation of Ridley's many-sided activities in Singapore and Malaya, and the reader is referred to this for a fuller survey of his life and work.

He was born at West Harling, in Norfolk, son of the Rev. Oliver Matthew Ridley and Louisa Pole (Stuart). He was proud to count among his ancestors Nicholas Ridley (Bishop of London, 1550–55), William Penn, and the third Earl of Bute, who was botanical adviser to the Princess Augusta, founder of the Royal Botanic Gardens, Kew.

Ridley took all Nature for his province. In his boyhood he was interested mainly in birds and insects; after studying natural science at Oxford he was awarded a scholarship in geology; he came finally to an intensive study of botany almost as an accident when, having failed to obtain a zoological post, he applied in 1880 for a post in the Botany Department of the British Museum (Natural History). In the following eight years he specialized in the study of tropical Monocotyledons, but did not neglect other groups of plants; and he maintained an active

interest in animal life, especially in the relations between plants and animals, in insects as pollinators and pests, and in birds and mammals as distributors of plants.

He thus went to Singapore in 1888 (as director of Gardens and Forests, Straits Settlements) well equipped to make the pioneer investigations of plant and animal life which were then needed, and to them he devoted the next twenty-three years of his life. In addition to the wide scope of his knowledge and interest, his other prime characteristic was the intensity of purpose with which he applied himself to everything that he did. With small financial resources, and little help from others, he achieved original pioneer work of a variety and scope such as few men have accomplished in a comparable period of time.

By his investigation of the tapping of Para rubber trees, and his persistent advocacy of the need for, and possibility of, a plantation rubber industry, he was largely responsible for making possible the development of modern Malaya. He was a wonderful field botanist, because he knew and could recognize such a great range of plants; he knew at once if he was looking at something new and interesting, when another collector might pass it unnoticed. He took every opportunity of travelling, and made by far the largest single contribution to our present knowledge of the Malayan flora. Several species of plants are still known only from his original specimens.

In addition to Para rubber, Ridley cultivated experimentally many other useful plants from outside Malaya. He wrote reports upon these plants, and on the techniques of handling them for local use. He also investigated, and reported upon, the many kinds of timber trees and other useful plants of the Malayan forest. His zoological papers were numerous and varied.

But because he had so many interests, and attempted such a wide range of work, and because he had so little help, everything he did was done in a hurry, and there is frequent evidence of this in Ridley's published papers and books. One thing he apparently had not the ability (or the patience) to do was to correlate his observations with those of other people; and through the habit of hasty work he apparently lost the ability of making careful and methodical records of his own observations. But it is not as a finished worker one must judge him; he was a pioneer, and showed the way for others who came afterwards, each to deal with only a fraction of the field he tried to cover.

Among those who travelled with him on his expeditions (as some of them have told me) Ridley had the reputation of being a good companion, always cheerful and resourceful. In his later years he had an inexhaustible fund of stories of his life in Malaya, and greatly enjoyed recounting them; from them one could appreciate his zest for life. He had a fine scorn of those with whom he disagreed, but a warm heart that made him beloved by many, especially by those to whom he quietly and generously gave practical help in time of need. One of his larger benefactions, which (at his own request) was never publicly announced, was a considerable gift towards the cost of A. F. R. Wollaston's expedition to New Guinea in 1912–13 (see *Geographical Journal*, **43**, 248–268).

At the age of eighty-two, Ridley married Lily Doran, who, with her sister, most devotedly cared for him during his later years and in his final illness.

R. E. Holttum

Prof. Doris L. Mackinnon

After an illness lasting almost three months, Prof. Doris Livingston Mackinnon died on September 10, at the age of seventy-two. She was the eldest of five talented children born to Lachlan Mackinnon, advocate of Aberdeen, and Theodora Mackinnon, *née* Thompson, of London, and she was born on September 30, 1883. Doris could draw skilfully, she had a good knowledge of music, and she had a great literary gift. Why then did she choose science as a career? Her father, who was a lover of animals, as well as an ardent amateur botanist, ornithologist and astronomer, would take the children for rambles in the country, to observe Nature in all its forms. Another influence in Doris's life was that of the late Mrs. Ogilvie Gordon, a noted geologist, who encouraged her to take up science seriously. She took her B.Sc. at the University of Aberdeen with the subjects botany, zoology and geology, graduating with distinction in 1906 and being, as I believe, the second woman to be capped in that University. A Carnegie Scholarship then enabled her to spend one year in the laboratory of Richard Hertwig at Munich, some months at the Biological Station at Roscoff, collaborating with M. F. Vlès in protozoological research, and a further period in the Quick Laboratory at Cambridge under the supervision of Prof. G. H. F. Nuttall.

During 1908–9 Miss Mackinnon acted as personal assistant to Prof. J. Arthur Thomson at Marischal College, Aberdeen, and in 1909 she was invited by Prof. W. D'Arcy Thompson to become his assistant at University College, Dundee. She remained in Dundee until the spring of 1916, and was then granted leave of absence to undertake war-work. During these years she established her reputation both as a brilliant lecturer and a protozoologist. In addition to her academic work, she gave a number of popular lectures in Dundee, Perth and Aberdeen, and by 1914, when she gained the degree of D.Sc. at Aberdeen, she had published fourteen papers, most of them dealing with the parasites of insects. In May 1916 she came under the influence of Clifford Dobell, who trained her at the Wellcome Bureau in matters relating to the study of amœbic dysentery. Another potent influence was that of her father's first cousin, Sir Patrick Manson. She then took up a War Office appointment as protozoologist attached to military hospitals. At the 1st Western General Hospital and at the School of Tropical Medicine, Liverpool, and later (1917) at the University War Hospital, Southampton, she collaborated with a number of colleagues in the publication of several important papers and reports concerned with *Entamoeba histolytica* and amœbic dysentery.

In 1918, when D'Arcy Thompson accepted the chair at St. Andrews, the Council of University College, Dundee, obtained her release from war-work, and she returned in April, running the Zoology Department single-handed. A year later she was appointed Prof. Arthur Dendy's senior lecturer at King's College, London, and in 1927 she became professor of zoology in the College.

Prof. Mackinnon's contributions to the original literature on her subject, most of which were concerned with the parasitic Protozoa, numbered about forty papers. Her sound knowledge of German was utilized in the translation of J. von Uexküll's "Theoretische Biologie" (1926) and in a translation of a musical book by Paul Mies, "Beethoven Sketches,

an Analysis of his Style, based on his Sketchbook" (1929). She also edited Berg's "Nomogenesis". Another side of her character is revealed by numerous articles, many of them studies of children and some of them childhood memories, which were published during the period 1913–19 in the *Manchester Guardian* and other periodicals. A course of broadcast talks for schools formed the basis of her book "The Animal's World" (1936), which appeals to adults even more than to children, and which reached an enlarged new edition in 1950. For many years Prof. Mackinnon worked on the preparation of her *opus magnum*, an illustrated text-book on protozoology, but she did not live to see this work quite completed. There is every hope, however, that it will appear in the near future, and those knowing the unusually fine quality of her teaching will look forward to its appearance.

As a colleague of Prof. Mackinnon for twenty years, I can vouch for the smoothness with which she ran her Department. She was an able administrator, and such a friend to her staff that her merest wish was equal to her command. Always ready to seek advice on such technical matters as perplexed her, she was equally ready to offer guidance to staff and students, whether on academic or personal matters. Many would testify to her kindness to them, for she lived for communion with her students, past and present. How she found time and energy to write to so many students so often and so fully, I for one cannot guess; but her self-imposed duty must have given joy both to herself and to many, particularly during the arduous years of war. All who have known Prof. Mackinnon will feel deeply saddened by the passing of a charming and gracious lady.

Ben Dawes

NEWS and VIEWS

Appeal from the University of Szeged, Hungary

The following communication, dated November 4, has been received from Prof. A. Szent-Gyorgyi, of the Marine Biological Laboratory, Woods Hole, Mass.: "I obtained from Hungary the wire quoted below, posted on November the 3rd, 6 p.m. I should be grateful if you could give room to it on your pages. 'To A. Szent-Gyorgyi, Marine Research Laboratory, Woods Hole, Massachusetts, U.S.A. The University of Szeged makes the following declaration: the newly born democratic Hungary wants to live in peace and friendship with its neighbours and all peoples of the world. We call on all Universities to support and help us with their moral authority in our endeavour to restore peace and independence to our country, which are the basic conditions of all scientific work. We ask all those men of learning with whom we established contacts at home or abroad, to come to our help. Up to the present we strived with all the modest means at our disposal to serve the progress and better future of mankind. We want also in the future to do everything possible to work in concert with the researchers of the whole world. We would be overjoyed if this desire could be fulfilled. We ask you to make this declaration known in possibly wide circles.' Here follows a great number of signatures, representing practically the whole senate and faculty."

Nobel Prize in Chemistry for 1956

The Nobel Prize in Chemistry has this year been divided between Sir Cyril Hinshelwood, president of the Royal Society and Dr. Lee's professor of chemistry in the University of Oxford, and Prof. N. Semenov, of the Academy of Sciences, Moscow, for their work on the kinetics of chemical reactions.

Sir Cyril Hinshelwood, F.R.S.

Sir Cyril Hinshelwood was elected president of the Royal Society in 1955, and reference was made to his many interests in *Nature* of December 10, 1955, p. 1101. This further honour which has come to him is a worthy recognition of the fundamental significance of his work on the study of chemical processes by kinetic methods.

Academician N. Semenov

Nikolai Nikolaievich Semenov, member of the U.S.S.R. Academy of Sciences and director of the Institute of Chemical Physics in Moscow, to whom, jointly with Sir Cyril Hinshelwood, this year's Nobel Prize for Chemistry is awarded, has long been known to all chemists for his outstanding contributions to the theory of chain reactions and explosions. The first major impact of his ideas on the world came with the explanation in terms of branching reaction-chains of the sudden ignition on slight increases of pressure of mixtures such as phosphorus vapour and oxygen in which, below the limiting pressure, there is little sign of chemical activity. His book, "Chemical Kinetics and Chain Reactions", published in England in 1935, contains an exhaustive analysis of the applications of the chain-theory to reactions of the most varied types, but notably to those involved in combustion processes. Among the many fruitful ideas which Semenov has advanced is that of degenerate branching, in terms of which some of the rather mysterious phenomena associated with the induction periods of oxidation reactions can be understood. Less well known, because published only in Russian, is his work on the propagation of explosion waves. Semenov has been, and still is, the centre of a distinguished group of Russian workers in various fields of physical chemistry, but principally devoted to the study of the mechanism of chemical transformation. It is an interesting circumstance that the two chemists who share this year's award have been on very friendly terms for many years, and met in Moscow on the occasion of the Academy's celebration of its 220th anniversary in 1945.

Royal Society: Medal Awards for 1956

The Queen has been graciously pleased to approve the following recommendations made by the Council of the Royal Society for the award of the two Royal Medals: Dr. Dorothy M. C. Hodgkin, reader in X-ray crystallography, University of Oxford, for her distinguished work in the elucidation of the structures of penicillin, vitamin B_{12} and other important compounds by the methods of X-ray crystallography; Dr. O. T. Jones, lately Woodwardian professor of geology in the University of Cambridge, for his

distinguished studies of the Palæozoic rocks, particularly in Wales, his work on sediments, his palæontological researches and the application of geological knowledge to practical problems.

The following awards of medals have been made by the President and the Council of the Royal Society: *Copley Medal:* Prof. P. M. S. Blackett, professor of physics in the Imperial College of Science and Technology, London, for his outstanding studies of cosmic ray showers and heavy mesons and in the field of palæomagnetism; *Rumford Medal:* Dr. F. P. Bowden, reader in physical chemistry in the University of Cambridge, for his distinguished work on the nature of friction; *Davy Medal:* Prof. R. D. Haworth, Firth professor of chemistry and head of the Chemistry Department in the University of Sheffield, for his distinguished contributions to the chemistry of natural products, particularly those containing heterocyclic systems; *Darwin Medal:* Dr. J. S. Huxley, for his distinguished contributions to the study and theory of evolution; *Hughes Medal:* Lord Cherwell, lately professor of experimental philosophy in the University of Oxford, for his distinguished work in many fields: the melting-point formula and theory of specific heats; ionization of stars; meteors and temperature inversion in the stratosphere.

The American Geographical Society: Medal Awards

THE Council of the American Geographical Society has made the following awards: *Cullum Geographical Medal:* Prof. J. Russell Smith, emeritus professor of economic geography in Columbia University, and author of several books on North America that have become classics in their field; *Charles P. Daly Medal:* Prof. Raoul Blanchard, long associated with the University of Grenoble, whose monumental work on the Alps will be completed with the appearance of the twelfth volume; *David Livingstone Centenary Medal:* Prof. George McCutcheon McBride, emeritus professor of geography in the University of California at Los Angeles, a leading authority on problems of economic and cultural geography in Latin America.

The National Zoological Park, Washington: Dr. William M. Mann

DR. WILLIAM M. MANN, who has been director of the National Zoological Park at Washington for thirty-one years, retired on October 31. Dr. Mann, who recently reached the statutory retirement age of seventy, was the fifth director the National Zoological Park has had since it was established by the Smithsonian Institution in 1889. He began his career in 1916 as an entomologist with the Bureau of Entomology, United States Department of Agriculture. It is widely recognized that under Dr. Mann's direction the Washington zoo has become one of the best and most representative collections of living animals in the world. The physical equipment of the zoo also has steadily improved, and during Dr. Mann's administration four modern exhibition buildings were added and others are planned. Dr. Mann is one of the world's greatest authorities on ants. He has collected and studied these insects around the globe, and only last year he presented to the Smithsonian Institution his huge personal collection of these insects, numbering more than 117,000 specimens. For the zoo Dr. Mann has made trips to many foreign lands to obtain live animals for the collection. For example, in 1926 he headed the Smithsonian–Chrysler Expedition to East Africa, in 1937 a National Geographic Society Expedition to the East Indies, and in 1940 the Smithsonian–Firestone Expedition to Liberia. He will continue his association with the Smithsonian in the capacity of honorary research associate, the Institution's highest honorary scientific designation. Dr. Theodore H. Reed, of Portland, Oreg., who has held the post of chief veterinarian of the zoo since July 1955, has been appointed acting director of the National Zoological Park.

The D.S.I.R. Research Council

THE Department of Scientific and Industrial Research Act, 1956, has now come into force, and the composition of the new Council of the Department is: Sir Harry Jephcott, chairman, Glaxo Laboratories, Ltd. (*chairman*); Sir Eric Ashby, president and vice-chancellor, The Queen's University of Belfast; Prof. C. E. H. Bawn, Grant-Brunner professor of inorganic and physical chemistry, University of Liverpool; Sir Hugh Beaver, managing director, Arthur Guinness, Son and Co., Ltd.; Prof. P. M. S. Blackett, professor of physics, Imperial College of Science and Technology, University of London; Mr. H. Douglass, general secretary, Iron and Steel Trades Confederation; Sir Walter Drummond, a director of George Angus and Co., Ltd., and also Smith's Dock Co., Ltd.; Mr. W. L. Heywood, general secretary, National Union of Dyers, Bleachers and Textile Workers; Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Co., Ltd.; Sir Philip Johnson, deputy chairman, R. and W. Hawthorn, Leslie and Co., Ltd.; Prof. E. A. G. Robinson, professor of economics, University of Cambridge. Dr. H. W. Melville, secretary of the present Advisory Council, will be secretary of the new Council. Payment of £1,000 a year to the chairman and £750 a year to each member of the Council is authorized under Section 2 (5) of the Act.

Large Heavy-water Reactor at Harwell

BRITAIN'S first large heavy-water reactor, DIDO, built for testing materials and making powerful radioactive isotopes, has started operating at Harwell. DIDO will develop about ten megawatts of heat at full power, and its neutron flux will be about 10^{14} neutrons per sq. cm. per sec. It is the most powerful experimental reactor in Western Europe. Heavy water is used as the moderator, and the fuel is highly enriched uranium. The reactor will be formally opened by Sir Cyril Hinshelwood, president of the Royal Society, on November 21. The name DIDO is derived from the formula D_2O for heavy water.

Precautions in handling Radioactive Isotopes

PARALLEL to the increasing use of radioactive isotopes by industry, there has been an increase in the demand for advice on the precautions required to ensure safe handling and disposal of radioactive materials, and both the Health Physics Division and the Isotope Division's Advisory Service on the Industrial Applications of Radioisotopes of the Atomic Energy Research Establishment, Harwell, have been active in this regard. During 1955 it was decided to supplement the services provided by the Divisions by a series of short courses of instruction on radiological protection, and the first course was held during November 1955 at Harwell. The course

lasted four days and consisted of lectures, demonstrations and practical work. Cyclostyled summaries of the nine lectures delivered during the course have been collected together in *A.E.R.E. H.P./L.23*, an unclassified publication which is now available for purchase (H.M.S.O., 13*s*. 3*d*. net). The subjects of the lectures included: "Elements of Nuclear Physics" (R. A. Faires); "The Organization of a Radiation Protection Service" (I. S. Jones); "Units in Radiation and the Detection of Radiation" (H. J. Dunster); "The External Radiation Hazard and its Control" (E. M. Flew); and "Decontamination and Waste Disposal" (R. H. Burns).

Traffic Problems in Britain

The present level of use of motor-vehicles in Great Britain was reached many years ago in the United States and it is desirable that we should profit by experience there when we decide how to tackle our traffic problems. That presumably is the object of the recent P.E.P. pamphlet, "Solving Traffic Problems: Lessons from America", and in it one might reasonably expect to find factual information as to the value or otherwise of American practice. Unfortunately, the report is confined almost entirely to quotations of American opinion, some of which fairly certainly comes from people with vested interests in particular branches of transport. It is thus difficult to know from the supporting evidence what value to attach to the conclusions drawn. It is particularly important that we should draw on American experience of the value of urban motorways in solving traffic problems. The report, however, gives no information such as Mr. Arthur S. Hodgkiss, the eminent and experienced expert from New York, gave to the recent conference in London on urban motorways when, in speaking of conditions in Great Britain, he expressed the view that "the development of urban motorways as a part of a national system of modern highways will more than pay for itself through direct and intangible benefits". Instead, the report emphasizes possible difficulties which might arise from the use of these roads by large amounts of car traffic travelling to and from work. Of course, the report is right in drawing the conclusion that the urban motorway will not of itself solve the traffic problem of Britain, which must be considered in relation to other factors and in particular to public transport and to parking policy.

It is disappointing, however, that the report can provide no clear indication from the United States as to whether the various restrictive measures that it seems to advocate are likely to be either acceptable or successful; whether in fact a proper balance which the report says "must be achieved between private and public transport" has been achieved anywhere; and whether it would be considered in the United States profitable to wait until traffic needs are "properly defined", whatever that may mean in present rapidly changing conditions, before getting on with the job. Great efforts should, of course, be made to collect facts—indeed, the Americans are the world's great fact collectors; but in reviewing American opinion, it is significant that Mr. Hodgkiss recommended the building of one urban motorway in Great Britain, so that we could see for ourselves the advantages that it gave, and suggested that if we studied too long in highway matters everyone became scared. This is an American 'get-on-with-the-job attitude' to which the report does not refer, but which is still held strongly in America's biggest city. It is indeed true that the United States has not solved the problem of traffic congestion; but it is a fact that the American cries out for more and more urban highway capacity. It would be wrong to convey the impression that the urge is diminishing, although it is right to say that more thought is being given to the better integration of all forms of transport, and to the conditions of use and to the provision of parking facilities.

Water Research News

Research in Great Britain on problems concerned with the availability and treatment of water for domestic supply was, for many years, carried out mainly by the technical staffs of local authorities. It had long been felt, however, that some central organization for conducting research in this field was desirable and the Institution of Water Engineers formed a Research Committee which, working through a number of groups, stimulated work on some of the many problems with which the water industry is concerned. This organization, though it did a great deal to foster research, suffered from the disadvantage that it had no permanent staff and could therefore act for the most part only as a co-ordinating body. In 1953 the British Waterworks Association, which represents all the public water undertakings in Great Britain, in conjunction with the Institution of Water Engineers, formed a Water Research Association, which last year appointed a permanent staff, housed, for the moment, in a large house at Redhill, Surrey. It is this body which has just issued the first number of *Water Research News*, a publication which is very attractively written and produced. It contains notices of two of the first technical publications of the Association—on instruments available for the detection of leaks in water mains, and on the treatment of aggressive water by aeration—together with short articles on the permeability of polythene to coal gas (a problem which has arisen in a few instances where polythene water pipes have been used), and on cathodic protection of buried mains.

Spaceflight

The British Interplanetary Society was founded in 1933 to promote the development of interplanetary exploration and communication by the study of rocket engineering, astronomy and other associated sciences, and it now includes among its members many British and foreign workers prominent in these fields. For many years the Society has published a bi-monthly journal, issued free to members, containing original papers of a highly technical and research nature. However, there is now a growing public interest in astronautics and since one of the Society's aims is to ensure the spreading of correct information, a new publication, *Spaceflight*, in addition to the Society's journal has been launched. *Spaceflight*, the first popular magazine of its kind, will appear quarterly and aims at giving a picture of the research work being undertaken as well as discussing related historical and astronomical matters. The first number contains a typical 'mixed bag'. The introductory article "Flight into Space", by W. N. Neat, gives a general introduction to the new science of astronautics and clears up a number of popular misconceptions about the basic principles and methods to be used. "Ideas behind the Rocket", by D. Hurden, is a very clear statement of the principle of rocket propulsion, what rockets look like and of the performance to be expected, and "The Vanguard

Project", by K. W. Gatland, is a 7,000-word article in which the United States of America's satellite project —called "Vanguard"—is explained in considerable detail and with numerous illustrations. The orbit selected for the satellite is inclined at 40° to the equator, and the launching is expected to be made before the spring of 1958 from the proving ground at Cape Canaveral, Florida, in a direction between 28° and 35° south of east. The satellite will move in an ellipse about the Earth, coming perhaps as close as 200 miles on one side and swinging out to as far as 800 miles on the other. It will complete a full circuit every ninety minutes. Details are also given of other proposed satellites to be launched as part of the programme of the International Geophysical Year and of the methods of tracking the progress of the satellites.

The Cambridge Instrument Co., Ltd.: 75th Anniversary

THE Cambridge Instrument Co., Ltd., celebrated the seventy-fifth anniversary of its foundation this year, and in commemoration of this interesting event a 28-page illustrated brochure has been issued in which the history and development of the Company are briefly outlined. The Company was one of the few pioneers in the introduction of instruments into industry, and it has played an important part in the subsequent progress over the years from the time when the scientific instrument was solely a university research tool to the present day when instrumentation is capable of controlling a complete factory. Some well-known instruments—the rocking microtome, the thread recorder, the electrocardiograph, the Wilson cloud chamber, Mallock's calculating machine, to mention but a few of those referred to and illustrated in the brochure—the Cambridge Instrument Co. can rightly claim as peculiarly its own. The original personnel consisted of Horace Darwin, a mathematician and a genius at designing instruments on kinematic principles; Dew-Smith, a wealthy experimenter; three mechanics and two boys. To-day, the Company has two factories and a head office and showrooms in London (13 Grosvenor Place, S.W.1); a factory in Cambridge; a separate mechanical thermometer division at one of the London factories; an associated American company; and representatives in most countries overseas.

The Miripinnati: a New Order of Teleost Fishes

THE creation of a new order of vertebrates is worthy of notice, even if it is only yet another order of fish. The teleosts are nowadays divided by many systematists into thirty or more orders, and in Dana Report No. 42 (pp. 34+1 plate. Copenhagen: Andr. Fred. Høst and Son, 1956; 10 Dan. kr.) E. Bertelsen and N. B. Marshall propose that four newly described species of teleost fish are sufficiently distinct to constitute a new order, the Miripinnati. The four species fall into three genera and two families. They are all oceanic, pelagic or bathypelagic fish, scaleless and apparently feeding on Copepods. One species, *Mirapinna esau*, known from a single specimen caught in 1911, is remarkable in having the body covered with 'hair', composed of branched outgrowths of the epidermis which bear glandular cells of an uncertain nature. The lateral-line organs of *Mirapinna* are raised on projections. In the second family, the Taeniophoridae, the skin is smooth and the lateral-line system apparently reduced; larval stages of members of this family are described. The Miripinnati are considered to be related to the order Iniomi.

Announcements

THE Royal Society is holding a conversazione and exhibition on November 21 to celebrate the tercentenary of the birth of Edmond Halley (see *Nature*, October 27, p. 891). The exhibits have been chosen by a special Tercentenary Committee of the Society under the chairmanship of Sir Edward Bullard.

THE 123rd meeting of the American Association for the Advancement of Science will be held in New York City during December 26–31, with headquarters in the Statler Hotel. In addition to the eighteen sections of the Association, eighty-five affiliated and associated societies will be holding meetings. Further information can be obtained from Sidney S. Negus, Medical College of Virginia, Richmond, Virginia.

THE following appointments have been made in the University of Birmingham: Dr. J. S. C. McKee, lecturer in physics; W. G. Ainslie, lecturer in engineering production; J. F. Soothill, lecturer in experimental pathology (metabolic diseases).

DR. D. S. BERTRAM, reader in entomology at the London School of Hygiene and Tropical Medicine, has been appointed to the University of London chair of medical entomology tenable at that School, in succession to the late Prof. P. A. Buxton. The title of reader in statistics in the University of London has been conferred on Dr. N. L. Johnson in respect of his post at University College.

COMMENCING January 12, a course of twelve lectures and appropriate practical work, designed to survey the principal branches of chemistry in which small-scale methods have been successfully applied, will be held on Saturday mornings, from 9.15 a.m. to 12 noon, at Norwood Technical College, Knight's Hill, London, S.E.27.

THE Thames Valley Section of the Royal Institute of Chemistry has arranged a symposium on "Techniques in Polymer Science" at Courtaulds' Research Laboratory, Maidenhead, on November 30 at 2.15 p.m. The topics to be considered include light scattering and osmometry, chromatographic fractionation, infra-red methods, surface films, tracer techniques and kinetic techniques. Further particulars can be obtained from the honorary secretary of the Section, Dr. P. F. Holt, University, Reading.

THE Fourth General Assembly and International Congress of the International Union of Crystallography will be held in Montreal during July 10–17, 1957, and will be followed by two symposia on July 18 and 19, dealing with physical techniques of crystallographic interest and with electron diffraction, respectively. A brochure on the Congress can be obtained from the secretaries of the national committees of the member countries of the Union; from the general secretary of the Union, Dr. D. W. Smits, Laboratorium voor Anorganische en Fysische Chemie, Bloemsingel 10, Groningen; or from the secretary of the Canadian Committee, Dr. W. H. Barnes, Division of Physics, National Research Council, Ottawa 2, Ontario (envelope to be marked 'Personal'); or from the chairman of the Programme Committee, Dr. W. N. Lipscomb, School of Chemistry, University of Minnesota, Minneapolis.

THE Society for Analytical Chemistry has moved its offices, and its new address is 14 Belgrave Square, London, S.W.1.

PAPER-MAKING APPARATUS AT THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

THE Paper-Making Section of the Textile Chemistry Department of the Manchester College of Science and Technology has been given laboratory equipment worth £5,000 by the Reed Paper Group. Mr. T. E. G. Baker, a director of Albert E. Reed and Co., Ltd., handed over the apparatus officially on October 24. The gift was received by Dr. B. V. Bowden, principal of the College, at a small ceremony attended by representatives of the Northern District of the British Paper and Board Makers' Association, executives of the Reed Paper Group and members of the College staff.

Although classes in paper technology were held in the Mechanics Institute, which preceded the College, they received their first big impetus in 1903 when the newly founded Municipal School of Technology acquired a demonstration paper machine 24 in. wide, and set it up in the new dyehouse. This fifty-year old machine is still put to good use for teaching and research. In 1905 the Faculty of Technology in the University of Manchester was instituted, and it then became possible for students in the Department of Applied Chemistry to take paper manufacture as a principal subject when studying for the degree of B.Sc. Tech. The Paper Technology Section later became part of the Department of Textile Chemistry, in which Dr. R. H. Peters was appointed to the first chair in 1955. The University approved the institution of an honours degree course in paper technology in 1954, and the first students taking this revised course obtained their degrees in the summer of 1956. The new degree course is based mainly on physics, to meet the current requirements of the industry. The course was designed by the late Dr. W. W. Barkas, who was appointed senior lecturer in paper technology in 1949 but died at the early age of fifty-six in 1955. The previous senior lecturer, Mr. F. W. Bailey, retired in 1949 after nearly twenty-five years at the College. He was a very welcome guest at the presentation of the new apparatus.

In 1954 the Northern District of the British Paper and Board Makers' Association instituted a scholarship fund, and since 1955 seven George Rackley scholarships have been awarded to full-time students reading for degrees. These scholarships have had more effect than might be expected, as in addition to the Rackley scholars other students have joined the Department with local authority grants. Research students have always been encouraged, and a new postgraduate diploma course has just been instituted for those who wish to study paper technology for one year only. At present there are twenty full-time students in the Section and, in addition, ten part-time students taking evening and part-time day classes.

The new equipment includes a Wennberg electrically heated rotating autoclave specially designed for making paper pulp on the pilot scale. This can be used either for demonstrations with regular raw materials such as wood, cotton rags or straw, or for research on any vegetable raw material. It will treat about 2 kgm. at a time. A disintegrator and strainer on the same scale are used for breaking up the pulp and removing uncleared fibre bundles.

'Beating' is the main mystery of paper making. The cellulose fibres suspended in water are passed between bars (usually bronze), which are rubbed together under considerable pressure. It is not easy to design a beater which will do this really well in the laboratory, as stock does not circulate properly in scale models of conventional beaters at the correct solids content. The Reed Group has given the College a 'Medway' beater designed in its laboratories. Though unlike a commercial beater in appearance, it will work over a wide range of operating conditions and is particularly suitable for demonstration and research.

The 'substance' (area-density) of paper is its most important property and has always been checked during manufacture by tearing out samples at intervals and weighing them; this necessitates joins in the reels. Substance is now controlled by beta-ray gauges in which the permeability of the paper to beta-rays from a thallium source is measured in a suitable apparatus. The gift includes a Baldwin 'Atomat' apparatus which is to be fitted on the College machine. By measuring substance at both ends of the machine, the water content at the wet end can be estimated.

A low *p*H in paper is bad for its permanence, and a high *p*H is detrimental to sizing. The control of *p*H is, therefore, important, and the apparatus includes an *EIL p*H meter which can be coupled to Honeywell–Brown recording and control instruments. The control system can be used, alternatively, for controlling temperatures and pressures and will be useful for demonstrating the principles of controllers to students.

The Van de Korput dynamic tensile tester measures the work done in breaking paper by applied tension. It correlates better with practical behaviour than conventional tensile testers. The Somerville fractionater is used for separating paper pulps into fractions of different fibre-length, and can also be used for straining. The study of coatings for paper is increasingly important, and the gift includes a Ferranti viscometer for checking the apparen viscosity and investigating the flow of these suspent sions.

F. L. Hudson

AGRICULTURAL POLICIES IN EUROPE AND NORTH AMERICA

THE Organization for European Economic Co-operation has issued an interesting report on agricultural policies in all European countries except the U.S.S.R. and its satellites, and also in Canada and the United States*. The picture is on the whole reassuring. In Europe the population has been increasing at the rate of about 1 per cent per annum, but the agricultural output has risen

* Agricultural Policies in Europe and North America—First Report of the Ministerial Committee for Agriculture and Food. May 1952. Pp. 372. (Paris: O.E.E.C.; London: H.M.S.O., 1956.) 18s.; 3 dollars; 900 fr.

by 4 per cent per annum since 1949/50. Food consumption per head has increased because of higher purchasing power; real income per head has during the past four years increased by 2·75 per cent per annum, and about half of this is spent in food.

The policies in the various countries have had the common aim of increasing agricultural output with the single exception of Sweden, where the present output of 107 per cent of domestic food requirements is to be reduced to 90 per cent. Planning has been generally abandoned; there are no longer targets for individual commodities as during the Second World War. What mostly happens now is that farmers are exhorted to produce all they can. A few countries have over-all targets: Great Britain is aiming at 60 per cent increased output over pre-war and has already achieved 56 per cent.

Germany has made the most remarkable recovery. During 1948–49 the agricultural output was nearly 30 per cent below pre-war; during 1954–55 it was 23 per cent above pre-war and was providing 70–75 per cent of the total food requirements in spite of the fact that the agricultural area per head had fallen by nearly one-third in consequence of the flow of refugees from Eastern Germany. There are no specific regulations—only a general requirement that food output must be as large as possible. Of the European exporters of food, Denmark, two-thirds of the export earnings of which are derived from food, aims at improved quality and higher degree of processing so as to increase the value per ton, rather than increasing the number of tons produced. The Netherlands have only the general aim of making agriculture contribute as much as possible to the national wealth: the exports include about 25 per cent of the crop output, 40 per cent of animal production and more than 50 per cent of horticultural production. In 1954, the total value of these exports was nearly 900 thousand dollars; but against this was an import of feeding stuffs, other agricultural commodities and human food amounting to 650 thousand dollars. Switzerland and the Irish Republic are among the few countries with a declared demographic aim: both desire to organize their agriculture in such a way as to maintain a large peasant population.

SIXTH INTERNATIONAL CONGRESS OF SOIL SCIENCE

THE Sixth International Congress of Soil Science, organized by the International Society of Soil Science, was held in Paris at the Maison de la Chimie during August 29–September 8, under the presidency of A. Oudin, Inspecteur Général des Eaux et Forêts, France. The Congress was divided into six commissions, the chairmen of which were as follows: Dr. M. B. Russel (United States), physics; Dr. A. C. Schuffelen (Holland), chemistry; Dr. P. Simonart (Belgium), biology; Dr. E. W. Russell (East Africa), fertility; Dr. A. Muir (Great Britain), classification; and Dr. J. V. Botelho Da Costa (Portugal), soil technology. The Congress attracted the largest number of members, the enrolment being 850 representing fifty countries, as compared with the two previous congresses in Amsterdam and Léopoldville (Congo), where the attendances were 600 and 250, respectively. Naturally, the largest group was from France, the next biggest groups being Great Britain, Belgium and the Congo, Holland, West Germany, United States, Spain, Italy, the U.S.S.R., Yugoslavia, East Germany and Switzerland.

The six hundred papers presented at the Congress, most of which were available in printed form, making four separate volumes, covered a wide field of problems, the most important being the influence of climate on soils, soil structure, soil colloids, acid soils, saline and alkali soils and their reclamation, phosphate and potash contents and nutrition, nitrogen transformations, soil micro-organisms, symbiotic, non-symbiotic, photochemical nitrogen fixation, trace (oligo) elements, forest soils and desert soils. Each author was given a quarter of an hour for outlining his contribution, followed by a discussion lasting 15–20 minutes.

In the afternoon of September 1 there was an interesting colloquium on fertilization and production of paddy, in which several soil scientists from Japan, China, India, the Congo and other tropical parts of the world took active part. A session on the morning of September 8 was devoted to a colloquium on the physico-chemical aspects of mineral nutrition by the plant roots. Some interesting papers were read; but there was no general unanimity of views regarding the mechanism of this process in crop production. As a side-issue of the Congress, there was an important colloquium on leaf analysis and plant nutrient supply, organized by Dr. P. Preaud, in which an introductory paper by Prof. T. Wallace was read.

Dr. Bruin, of Holland, put forward the proposal that soil scientists hailing from temperate countries should co-operate in obtaining accurate data on the influence of nitrogenous fertilizers in crop production, and he arranged the convening of a meeting for this purpose in Groningen in November. It is well known that nitrogenous fertilizers are not much used in Asiatic countries, where the majority of the human beings of the world subsist. Moreover, only 3 per cent of the world crop yield has been attributed to artificial nitrogenous fertilizers, as reported at the meeting of the British Association in 1949 in Newcastle (see *Nature*, 164, 597; 1949): "At present only some three per cent of the world food production can be attributed to the use of nitrogenous fertilizers. To raise the available food by ten per cent, that is to say, one hundred million tons, involves a fourfold increase in supplies of fixed nitrogen, at an approximate capital cost of £1,500,000,000. . . . This . . . would take a minimum of 15 years to achieve". Hence, even to-day world food production has to be mainly attributed to the soil nitrogen present in the soil organic matter or humus, the study of which from different angles attracted the attention of a large number of members of the Congress.

On September 7 there was a whole-day excursion for the study of soil profiles and other topics of agricultural importance in the Paris area. After the Congress, excursions lasting a week were made in different parts of France for the study of soils. In addition, on September 2 several members were taken around the National Agricultural Research Institute at Versailles, and the following week a group visited the Institute at Bondy, 20 km. from Paris, for training French soil scientists for work in the Colonies and research work on problems of Colonial agriculture.

The general conclusion among members was that this Congress not only contributed to the difficult problem of the amelioration of the world food situation, but also achieved progress in international fellowship and goodwill in the friendly atmosphere of the meeting and parties. The next Congress will be held in the United States in the summer of 1960 under the presidency of Prof. R. Bradfield, of Cornell University.

N. R. Dhar

UNITED NATIONS TECHNICAL ASSISTANCE PROGRAMMES

THE eighth report of the Technical Assistance Board to the Technical Assistance Committee of the United Nations Economic and Social Council* describes the progress and developments during 1955 of the Expanded Programme of Technical Assistance for Economic Development and includes also some details of activities to be undertaken in 1956 and of plans for 1957. The general level of activities was markedly higher, and the contributions of 27·9 million dollars from seventy-one countries, compared with 25 million dollars in 1954, permitted assistance to be given to a hundred and one countries and territories. At the end of the year, some fourteen hundred experts were collaborating with their counterparts in the less-developed countries, and while it is not practicable to isolate the impact of technical assistance on economic development or to measure it precisely, it is clear that significant results have been achieved in many technical assistance activities.

During the year, geological maps of forty-five regions of Bolivia, to be used in prospecting for oil and other minerals, were completed, as was a similar survey in the Yemen. The first geological map of Nepal is being prepared, and a geological survey institute was set up in Afghanistan. Assistance was given in aerial surveys of forests in Brazil and Iraq, and surveys of ground-water resources in Jordan and Pakistan were being expanded, while in Indonesia a team of eight experts assisted the National Planning Board with the preparation of a five-year development plan and investment programme. Expert advice and the assistance of workers trained abroad under fellowships has enabled the production of DDT and penicillin to be commenced in Chile, Egypt, India, Pakistan and Yugoslavia, while the petrochemical industry in Venezuela has been assisted in the establishment of what will be the largest factory in South America manufacturing fertilizers and insecticides. Assistance given since 1951 to the cottage and small industries of Burma has led to these industries playing an increasingly important part in the country's economy, while throughout the world, nearly a thousand engineers, foremen and skilled workers from all branches of industry have been trained under the worker-trainee programme and large vocational training schools have been opened in Brazil, Guatemala, Haiti, Indonesia and Iran.

Port and shipping experts were assisting the Governments of Jordan and Yemen with the reconstruction of the ports of Aqaba and Ras-el-Khatib, and nineteen countries received expert advice on the improvement of their civil aviation; more than 1,140 students completed courses at schools in various countries of the International Civil Aviation Organization during 1952–55. Irrigation and land reclamation received much attention in Syria and in large river basins such as those of the Ganges-Brahmaputra, the Tigris and the Euphrates. In a pilot area of 230,000 acres on the right bank of the Ganges in East Pakistan, about one-fifth of the main canal has been excavated with the support of the Colombo Plan and the International Co-operation Administration of the United States, and it is expected that irrigation water will be available in the Kushtia area by the end of this year. Recommendations made by specialists of the Iraqi Development Board on the advice of a geologist of the United Nations Food and Agriculture Organization have led the Government to allocate 4·5 million dollars for drilling wells, fifty of which have been completed or are under construction. A pilot area on the Volta River in the Gold Coast has been brought under experimental cultivation, and in Afghanistan, Egypt, Iraq and Libya demonstrators have been trained to introduce new techniques and improved small tools to farmers. Some of the field workshops in the large-scale farm-mechanization plan of Uttar Pradesh in India have increased their output by nearly 300 per cent, and more than five hundred instructors and operators have been trained by international experts.

New varieties of cotton are being tried in Iran, and cultivation trials in Yugoslavia have given a substantially increased yield of cotton per acre. Programmes for increasing the production of wheat and rice have been undertaken in Egypt, and a scheme for developing coffee cultivation has been started in Ethiopia. Assistance given in Central America and Mexico has enabled local authorities to keep the locust plague under control everywhere except Northern Honduras, and the control of olive and fruit flies has been developed in Libya. With the building up of supplies of vaccine to control rinderpest and other animal diseases in Afghanistan, Austria, Burma, Ceylon, Ethiopia, Honduras, India, Iraq, Pakistan, Thailand and Yugoslavia, the emphasis of technical assistance has shifted to the organization of field control schemes.

The training of school teachers has from the start been an important feature of the Expanded Programme of Technical Assistance, and in 1955 more than a thousand rural teachers attended courses in Haiti, while about 2,500 have been trained in the Philippines since work started in 1953. In Indonesia more attention has been paid to training teachers for rural communities, while assistance in teaching science has ranged from the organization of a chemical laboratory and of a scientific instruments centre for the National Council of Research in Egypt to the development of institutions for arid zone research in Brazil and Peru. In Turkey the Institute of Hydrology has now reached the stage when its work can proceed satisfactorily under the direction of national staff, and an international team, which in 1954 completed the organization of a scientific and technical documentation centre in Mexico for the Latin-American countries, is organizing a similar centre in Egypt to serve the Arab States.

Much assistance has been given to governments in training health staff, the control of communicable

* United Nations: Technical Assistance Committee. Eighth Report of the Technical Assistance Board. (Economic and Social Council. Official Records: Twenty-second Session, Supplement No. 5.) Pp. vi+104. (New York: United Nations; London: H.M.S.O., 1956.) 1 dollar; 7s.; 4 Swiss francs.

diseases and in strengthening national health services. During the year about 570,000 persons in Morocco and Tunisia were treated for trachoma, a high percentage of cures being obtained. Measures were taken to protect about two-fifths of the estimated population of South-East Asia against malaria, and epidemic malaria is no longer prevalent in about half the island territories of the Caribbean; but it has become a matter of urgency to intensify the effects to eradicate malaria in these regions before the anopheline vectors develop too great a resistance to the insecticides at present used for their control. In Indonesia the mass campaign against yaws has brought the disease under control in about thirty areas, while in Thailand 7·5 million people have been surveyed and about 750,000 treated for the same disease. As examples of assistance given to improve housing conditions, the report cites the establishment in India of a research centre to study the socio-economic and technological aspects of housing development in a dry tropical climate and of another in Indonesia to study these factors in a humid tropical climate. More than a thousand Civil servants of various grades received training during the year, and in Jordan, on the recommendation of an expert on Civil Service reform, a Civil Service Department and a Civil Service Commission were set up; technical consultants in Bolivia helped to draft legislation establishing a permanent Civil Service, and the postal services in Iran, Lebanon and Uruguay have been considerably improved as a result of international advice and assistance.

Although most of the experts supplied in 1955 were recruited from Europe and North America, they were drawn from sixty-nine countries and territories, and workers in receipt of fellowships studied in ninety-four. During the year, 2,431 fellowships were granted, as compared with 1,524 in 1954 and 1,195 in 1953, and there has been a growing trend towards the establishment of training institutes within countries which are receiving technical assistance. Special attention has been paid to co-ordination of the technical assistance provided under the expanded programmes and under bilateral aid programmes, while the general financial stability of the Expanded Programme considerably improved during the latter part of the year.

INDIA'S CONTRIBUTION TO THE HISTORY OF MEDICINE

THE publication, in June, of the first number of the *Indian Journal of the History of Medicine** is in itself an event of historic importance. Much of the credit for this noteworthy step is due to Prof. D. V. Subba Reddy, who founded the Indian Association of the History of Medicine nine years ago, and became its first secretary. Prof. Reddy is editor of the new *Journal*, which is to be the organ of the Association and will be published twice a year, and he will also shortly vacate his chair of physiology in the University of Madras in order to assume the duties of a chair of history of medicine, the first of its kind in India.

* *Indian Journal of the History of Medicine*, **1**, No. 1 (June 1956). Pp. iv + 69. (Madras: Indian Association of the History of Medicine, 1956.) Rs. 8 per year (two issues) or foreign currency equivalent to Rs. 12.

By the creation of a new chair and a *Journal*, India has recognized, most opportunely, the importance of a historical perspective in medicine. The Medical Education Conference, set up by the Government of India, which met in Delhi in November 1955, acted wisely in recommending that history of medicine should be included in the medical curriculum. This decision was made for several reasons. Not only has the subject a special cultural and humanistic value, but also, as the report of the Conference states, "after studying the history of medicine, the future medical practitioner will be better equipped for his profession under conditions prevailing in this country. Our people think and talk about their illnesses in terms of ideas and expressions based largely on our ancient systems of medicine. How can a physician understand fully what his patient describes as his symptoms unless he has an acquaintance with these ideas and ways of giving expression to them?"

This very appropriate argument in favour of the study of medical history may not apply in every country, but it is certainly valid for India. Events have moved rapidly, and already the report has borne fruit. Dr. Reddy is to be warmly congratulated on the high standard which has been attained in the first number of his *Journal*. It is a veritable mine of information on the early medicine of India and the East. The opening paper, which was originally an address to the Association, is a scholarly contribution by Prof. J. Filliozat (French College at Pondichery) on Ayurveda and foreign contacts, showing the links between Indian medicine and Greek medicine; Prof. P. Kitumbiah (Christian Medical College, Vellore) contributes a paper on the concept of heart and blood-vessels in ancient Hindu medicine; and Prof. M. V. Sastry (Madras) writes on training for medical practice in ancient India. Prof. Reddy himself supplies an article on Buddha's discourses on medicaments, treatment and nursing; other authors deal with nursing under ancient Indian systems, with Arabian medicine and with Rhazes' *magnum opus*, "Al-Hawi, or Continens". The *Journal*, which is well produced and clearly printed, will be published twice a year. It deserves every encouragement.

This recognition by India of the importance of history in medicine is a welcome sign of progress. Many other countries have become aware of their medical heritage. Throughout Europe, nearly every university has its chair of history of medicine and there are many institutes which serve as centres of knowledge. In the United States and in South America, especially in Brazil and Venezuela, close attention is given to the history of medicine.

Towards this widespread awareness of the value of history as a cultural and ethical basis of medical education, Britain alone shows an attitude of almost complete indifference. In London, the Wellcome Historical Medical Library and Museum continue to stimulate and keep alive an interest in the past, as also do the various societies of history of medicine, in England, Scotland and Ireland. The tale of neglect is truly surprising. Nevertheless, a more cheerful attitude is foreshadowed by the recent news that a British journal—the only one of its kind—entitled *Medical History*, will commence publication next January under the editorship of the well-known medical historian, Mr. W. J. Bishop, and will appear quarterly.

One of the strongest arguments in favour of medical history is that it directs attention to the ever-present need for an application of the principles originally

embodied in the Oath of Hippocrates. Recognizing this need, the universities and medical schools of Europe, since the days of the School of Salerno, have demanded of their graduands some form of promise based upon the Hippocratic Oath, and this practice is now followed in many parts of the world. In Britain, although each of the four Scottish universities follows the age-long tradition, only two or three of the many English universities accord any official recognition to the great charter of medical conduct which has come down to us through the centuries from the time of Hippocrates. Surely a knowledge of such ethical principles, if not also of the pioneers who codified and practised them, should be regarded as a feature essential to every medical curriculum?

Accordingly, while we in Britain may well congratulate our Indian colleagues upon their foresight in appreciating the value of the historical aspect of medicine, we may at the same time feel ashamed of our own failure to do so. There is still much to be accomplished in the reform of medical education, and, if medicine is to remain one of the learned professions, more stress must surely be laid upon ethics and humanism, which only reveal their importance during a study of the history of medicine. For Hippocrates, medicine was ever "The Art". Only as an art can it preserve its fine tradition. All honour, therefore, to India for reminding us that only by looking backward can we recapture the true spirit of medicine. In this way alone can we effectively face the future.

DOUGLAS GUTHRIE

THE MYXOPHYCEAE AND CHLOROPHYCEAE OF NEW ZEALAND

SOME comparatively recent American marine Floras have set a satisfactory standard against which a reader is prone to measure new works of a similar kind. Of prime scientific importance would seem to be the provision of concise but complete diagnoses of the various taxa, namely, orders, families, genera and species, including details of both vegetative and reproductive characters. Good keys based on easily discernible characters (and, so far as possible, macroscopic features of the vegetative parts of the thallus) should lead to the relevant descriptions. Good illustrations should reinforce the statements about the salient characters of the genus, both vegetative and reproductive. In some genera this would need to be supplemented by illustration of one particular character for all the species, where it is of prime taxonomic importance. Lastly, in a group of plants in which terminology is notoriously imprecise, a glossary is necessary. From the practical point of view, a Flora should be of manageable size and provided with firm covers.

The first part of the "Marine Algae of New Zealand", by Prof. V. J. Chapman, that dealing with the Myxophyceae and Chlorophyceae (*J. Linn. Soc. Lond.*, 55, No. 360, 333–501; July 1956; 42*s.*), falls short of these standards. Since the work is published in a journal, the author may not have had an orthodox Flora as his aim; but if not, what was it, as the paper has the form of such but without much of the substance? The species descriptions are brief and would probably prove difficult, therefore, for beginners. One of the shortest is that for *Ostreobium reineckei* Born., namely: "Filaments intricately spreading, the ends of the branches consistently free". Even the newly described species are not given very lengthy treatment. Throughout the work, mention of the reproductive organs is very meagre, and illustrations of these parts of the thalli are conspicuous by their absence. References to other works are given under the binomial system; but it is not clear what rule has governed the choice of citations when it is not the original description. Keys at the beginning of each of the two sections lead to families and not orders and yet keys are given again under each order to the families of that order, so that there is considerable duplication. The Wittrockiellaceae is an exception, as it occurs under the order heading only. No glossary is provided, and sometimes the choice of terms is not good; for example, "plant body". Again, in Table 1 "exposure" is used to mean something different from the same word on the opposite page (p. 339), where it is the equivalent of emergence (cf. p. 335). "Filamentous" is also used in more than one sense, in some instances to signify the construction of the thallus and in others to describe its filiform shape.

An editor's note explains that the twenty-seven plates are reproduced as faithfully as the quality of the illustrations provided allowed, and this would appear to be the case. Legends for these plates would have added to their value, especially since notes on the illustrations are not always legible. Some of the one hundred and fifty-three text-figures, which are the work of the author and his associates, lack information about magnification and also precision as regards other details. Hence they are not always as informative as could be wished. In spite of its certain lack of perfection, the work is a considerable advance on Laing's list of 1926. In the latter, there are only seven species of Myxophyceae and forty-six Chlorophyceae, whereas in the work under review there are fifty-four species of Myxophyceae and two hundred and five species of Chlorophyceae. This indicates the amount of work which has gone into the preparation of this Flora in the comparatively short amount of time since Prof. Chapman went to New Zealand. Moreover, the paper was read at the Linnean Society more than two years ago.

Although the number of species of Myxophyceae listed is greatly in excess of that of Laing's list, the author points out that it is likely that more exist on the shores of New Zealand, and this is doubtless the case. The species known already are ones with a wide distribution in the world and there is only one doubtfully endemic species, *Tolypothrix irregularis*. In contrast, out of two hundred and five species of Chlorophyceae listed, ninety-two (47 per cent) are endemic. Some of these have a restricted distribution so far as is known at present. The new genus, *Gemina*, is characteristic of southern cold waters, and *Bryopsis* is a conspicuous genus in South Island, from which district have come species not previously described. The author goes so far as to suggest that the South Pacific is either the home of the genus or that active evolution is taking place around the shores of New Zealand. The genera *Lobata* (Ulvaceae) and *Rama* (Cladophoraceae) as well as *Gemina* (Ulvaceae), all described earlier by Chapman, are included in the Flora, as well as many new species.

In the Myxophyceae, the author has accepted Drouet and Daily's (1948) views on the classification

of the Chamaesiphonaceae, but apparently not on the Chroococcaceae. The classification is said to be that of Fritsch (1945). Likewise, although the author states that the classification of the larger taxa of the Chlorophyceae in this work follows that of Fritsch (1935), this is not strictly so, but is modified, as Chapman has himself advocated in other papers. Five families, the Ulotrichaceae, Monostromaceae, Ulvaceae, Caposiphonaceae and Prasiolaceae, are included in the Ulotrichales. The Siphonocladales also has not the same limits as the Cladophorales in Fritsch's book of 1935. However, this is not the place to digress into questions of the much-debated classification of the Chlorophyceae; but it is perhaps opportune to emphasize that the existing classificatory systems rest primarily on the comparative morphology of the adult thalli and that there is need that this should be supplemented by intensive studies of developmental morphology and life-histories. As for the smaller taxa, the Chlorophyceae includes some genera which are notoriously difficult, such as *Ulva*, *Enteromorpha* and *Cladophora*, genera which would provide suitable material for investigation by one of the modern methods of taxonomic treatment such as have been used successfully for 'difficult' genera of higher plants. Here they are classed as species, varieties and forms; but in the case of *Enteromorpha*, Chapman uses *"ecad"* as a taxonomic term. This may indicate his views on the cause of variability in this genus; but its use here is valueless as well as illegitimate.

KATHLEEN M. DREW

AGRICULTURAL RESEARCH AT THE SUDAN CENTRAL RAINLANDS STATION, 1952–56

By DR. A. H. BUNTING*

Recently Senior Research Officer, Sudan Ministry of Agriculture

THE clay plains of the eastern Sudan occupy many thousands of square miles under normal annual rainfalls of 500–800 mm. In 1952, following several years of experience of partly mechanized sorghum production in part of the region[1], the Research Division of the Sudan Ministry of Agriculture opened the Central Rainlands Research Station (Tozi Research Farm) to explore its wider potentialities. Tozi is about a hundred miles south of Sennar and eight miles west of the Blue Nile (lat. 12° 30′ N., long. 34° 00′ E. approximately). The fifth season of farming and research is now in progress on about 1,300 acres, while housing and essential services have been produced for a community of several hundred, and simple offices and laboratories have been built and partly equipped. The senior staff has fluctuated from three to eight. This article records the more significant results and indications of the work so far.

The programme has been based on the study of crops in the field. About 1,700 rows and plots of a wide range of crops and varieties were grown in 1952 for observation and selection. American cotton, sorghum, groundnuts, sesame and safflower (and more recently maize) appear best suited to the conditions. In 1953 simple and separate trials were used for locating the critical ranges of crop population, planting date and fertilizer nitrogen-level in the main crops, and bulk production, mechanized so far as possible, occupied about 1,000 acres. In the third season somewhat complex multifactorial experiments were introduced to unravel the interrelations of crop population, nitrogen-level, varietal type and sowing date. Around this central agronomic core, soil, plant protection, breeding and other specialist studies have developed. Results, indications and even speculations from research and production are co-ordinated to guide the field-cropping programme each season, so that progress is by successive approximation. Conversely, an annual analysis of field-scale results opens up new lines for research.

* Present address: The University, Reading, Berks.

The Environment

Over four seasons the rainfall has averaged 680 mm., against a probable normal value of around 700 mm. (about 27½ in.), mostly received during June–October. Part of it falls in cyclonic storms, the intensity of which has varied seasonally. During July–September the temperatures are buffered around 30° C. maximum, 20° C. minimum, with dew points around 20° C. In late October the southerly transit of the intertropical front suddenly brings in dry air and markedly increases evaporation-rates. The dry season (November–May) is long and hot (up to 44° C. max.), though the winter nights (December and January) are cool.

The vegetation is an *Acacia* spp. (largely *A. seyal*), open woodland with tall grass, 10–15 ft. high, with areas of open grassland of various types. The grasses are almost all upright annuals, burnt off each year by fierce bush fires. The stringent ecological conditions restrict the number of plant species to about three hundred; most of the important forms are legumes. Methods for ecological land-use selection have been broadly determined.

Soils and Water Relations

The soils are formed from deep unleached, alkaline alluvial clays, and have about 70 per cent montmorillonitic clay content and *p*H 8·5–9·0. They are fully plastic at field-capacity and crack heavily on drying, while the top few inches fall to a friable mulch. Their colour and extent of base accumulation (but not their content of clay, nitrogen or organic matter, which is less than 1 per cent under natural vegetation) are related to slight topographic differences: lower sites are darker and more alkaline, with more salts and calcium carbonate.

There is no permanent water-table in the soils. After the rains they are dried to wilting point (20–25 per cent moisture on dry weight or less) by transpiration or evaporation. In the new season, water

enters, at first down the cracks and then by bulk penetration with a defined front. The ultimate depth of penetration depends on the current balance between percolation and evapo-transpiration, which in turn depends on the seasonal rainfall pattern. The penetration in undisturbed bush, where transpiration starts soon after the first showers, seems generally less than in cropped fields sown a few weeks later. Concentrated rainfall can lead to serious local flooding on unplanted land, so that permanent surface drainage systems may prove essential.

Since crop roots do not enter the physiologically dry soil below the water front, the depth of soil exploited for nutrients and water also depends in part on the rainfall pattern, as well as on the root behaviour of particular crops or varieties. This broadens considerably the concept of soil fertility. Though nitrogen is the only nutrient to which responses are regularly obtained, they have been economic so far only in groundnuts and maize. Cotton and safflower, the growth of which at Tozi is primarily restricted by water shortage, do not respond, and sorghum and sesame are intermediate. The response in groundnuts perhaps reflects the relatively late stage of the crop's short life (90–95 days at Tozi) at which nitrogen becomes available from the numerous, large and apparently effective nodules. Important phosphate effects have been seen only in maize, while potash improves leaf appearance in Virginia tobacco. Zinc is important (together with nitrogen and phosphorus, though the interactions have yet to be worked out) only for maize; but this appears to be more a question of poor root penetration than of a soil deficiency in the conventional sense. No doubt if humus were more abundant, trace element shortages would be more frequent.

Crop sequence experiments were started in 1952 using a two-year design measuring residual effects of crops, fallows and fertilizer nitrogen. Many of the effects can be interpreted conventionally in terms of nitrogen or water relationships. Maize and sesame do not penetrate the soil far enough to use all the available water, so that some accumulates. Bare fallowing checks subsequent crops, even if the stored water is removed with late-sown safflower; but striking benefits of half-fallowing have been seen.

Crop Breeding and Agronomy

A collection of nearly a thousand local and introduced varieties of sorghum is maintained at Tozi. Three high-yielding combine varieties, selected from indigenous material, are being grown on a field-scale in 1956. The optimal population ranges and planting dates are found to be respectively higher and earlier than has been usual in the past, with the result that yields of 2,500–3,500 lb./acre are common in experiments, while 79 acres of bulk production in rotation averaged 2,200 lb./acre in 1955.

The highest-yielding cotton varieties tested have been the Sudan-bred blackarm resistant BAR. 7/8.1 and BAR. 7/8.2. Early sowing (June) and high population (more than 30,000 plants/acre) have given experimental yields of 1,500 lb. seed cotton/acre and more; field-production in 1955 averaged about 1,170 lb./acre on 86 acres, and a small area, about a third of an acre, following an accidental half-fallow, yielded at the rate of 2,200 lb./acre.

More than 250 uniform, classified varieties[2] of groundnuts are maintained. The upright bunch variety, Barberton, established for several years in the Sudan, has hitherto proved the best; but progeny testing has now given similar experimental yields from the newly introduced Natal Common. Yields of 1,500 lb. kernels/acre are quite common, and well over a ton has been harvested, in experiments, while field yields averaged 900 lb./acre on 106 acres in 1955. High populations (60–80,000 plants/acre) and timely harvesting are essential.

Breeding programmes in sesame aim at transferring the Venezuelan indehiscence, and the early and profuse flowering of certain American types, to the local material, which is at present used in field-production. Root penetration is relatively poor, and the crop is sensitive to drought in its later stages. While experimental yields have reached 1,200 lb./acre of seed, the general run is similar to the field-yields at 500–700 lb./acre.

Safflower, a crop extremely resistant to drought, is sown late after a summer fallow, to mature on stored moisture. Yields are unaffected by fertilizer or variations in population. Selection is aimed at the production of early and profusely flowering upright types. Field yields are 400–500 lb./acre only, although in experiments up to 1,200 lb./acre has been realized.

The work on maize nutrition at Tozi (see above) permitted the production of this crop on the clay plains for the first time in 1955. Introduced varieties including hybrids yielded 3,000–3,800 lb./acre in preliminary observation plots and rows; local Sudan material (from recent riverain silts) gave 2,000 lb./acre on 6 acres.

Minor crops studied include deccan hemp (kenaf), sunflower (where some progress seems to have been made in concentrating a self-fertilizing character), soya bean and Virginia tobacco. The local perennials Rhodes grass (*Chloris gayana*) and *Clitoria ternatea* (a prostrate legume) seem likely to be useful, perhaps in mixture, in sown pastures.

Crop Protection and Farming Practice

Though many potential sources of trouble, including stainers, bollworms, grasshoppers, stemborers and the *Puccinia polysora* rust of maize, have been recorded, no serious attacks of pests or disease have so far occurred at Tozi. Rosette disease of groundnuts is absent from the region, and the cotton varieties in use are sufficiently resistant to blackarm. Soil-borne diseases and pests of the seed-bed make it essential to use combined insecticidal and fungicidal seed dressings for sorghum and groundnuts, and for the latter a soil dressing of 1 lb./acre of dieldrin is standard practice and helps to control thrips and termites.

All land preparation, sowing, inter-row cultivation, ridging and field spraying are mechanized, though on a heavy clay soil under tropical rainfall a high degree of farming skill is necessary to use machinery efficiently. Sorghum and safflower are combined. Groundnuts can be harvested, threshed and decorticated mechanically, but so far the operations are slow and require very careful timing and organization. Cotton and sesame are harvested by hand at present. Tractor-hour records suggest that all the main crops, and particularly cotton and sorghum, are economic at the present levels of field-yield.

[1] Sudan Government, Ministry of Agriculture, 1954. Working Party's Report on the Mechanical Crop Production Scheme. Rotaprint. Pp. iv+48+22 diagrams.

[2] Bunting, A. H., *Emp. J. Exp. Agric.*, **23**, 158 (1955).

MARINE FISH FAUNA OF THE GOLD COAST

By Dr. E. A. SALZEN

West African Fisheries Research Institute, Freetown

PART of the work of the West African Fisheries Research Institute is to explore the whole of the West African continental shelf for potential trawling grounds, and to determine the nature and extent of such grounds for possible future exploitation. A recent survey with the F.R.V. *Cape St. Mary*, a 100-ft. diesel trawler, of the continental shelf off Tema in the Gold Coast gave results which are of considerable interest because of their similarity with those obtained by Postel[1] working off French Guinea. Yet these two areas are a thousand miles apart and the French Guinea shelf is more than 70 miles wide compared with 14 miles at Tema. It may be, therefore, that the results for Tema are typical of a great deal of the West African shelf in the dry season.

The survey covered the whole of the shelf for 20 miles on either side of the port of Tema. Twenty-eight stations in depths of 10, 20, 30, 50, 100 and 200 fathoms were distributed in five transects at eight-mile intervals along the shelf. Fifty-eight hauls were made, mostly of one hour duration. One day and one night haul were made at each 10–50 fathom station, and one day haul was made at each 100 and 200 fathom station with hauls of 2-hr. duration at the latter depth. All the hauls were made with the same gear (Peter Carey trawl, 72 ft. head-rope, 10 ft. legs, 15 fathom sweeps and Dan Lenos with rollers), towed at the same engine speed but in varying relation with the direction and speed of the tide. Three hauls were made at each station on one of the transects in order to obtain a measure of the variance in rate of catch for the same ground. This showed that the variance and mean rates of catch for different stations at the same depth did not differ significantly from the variance and mean rates of catch for repeated hauls at the same station and same depth. This suggests that the fish population in the Tema area does not vary along the shelf.

The results for the hauls were, therefore, grouped according to depth. The rates of catch for the various depths and for day and night trawling are shown in Table 1. They are comparable with rates of catch obtained by Whiteleather and Brown[2] in the Gulf of Paria and off British Guiana, and with fishing in Australian waters reported by Houston[3] and Fairbridge[4]. They are better than the results obtained off Bombay by Hefford[5] and on the Patagonian shelf reported by Hart[6]. The changes in rate of catch with increasing depth are very similar to those found by Postel[1] for the French Guinea shelf. The correspondence between this region and the Tema area extends to the nature of the bottom and to the nature and distribution of the fish species, the same species occurring at the same depths in both areas. Postel found a distinct change from euryhaline and eurythermal species in the shallow inshore water, to red and brown marine species below 10 fathoms. The results for the Tema area show the same change involving the same species. In addition, as can be seen from Table 2, there is a more subtle change in species which takes place from 20 to 100 fathoms. The predominant species change with depth, and this is a very important change from the fishery development point of view because the species become of smaller average size and lower commercial value with increasing depth. At 200 fathoms the fauna appears poor and abyssal in nature, with a few coryphenids and stomiatids.

The correspondence between the Tema area and the French Guinea shelf poses the question as to

Table 1. Relation between Rate of Catch and Depth for Day and Night Trawling

Depth in fathoms	Day fishing		Night fishing	
	No. of hauls	Rate of catch kgm./hr.	No. of hauls	Rate of catch kgm./hr.
10	10	98·6	5	127·9
20	7	78·4	6	156·6
30	8	69·6	4	94·6
50	5	46·5	4	97·0
100	5	103·5	—	—
200	2	1·4	—	—

Table 2. Distribution with Depth of the Predominant Fish Species in the Tema Area

The table shows the number of hauls in which more than 1 kgm. of the species occurred expressed as a percentage of the total number of hauls at that depth. The species are therefore the ones which are of economic importance

	Percentage frequency of occurrence (values greater than 25 per cent only)				
Depth in fathoms	10	20	30	50	100
Species					
Otolithus macrognathus	33	—	—	—	—
Ephippus lippei	27	—	—	—	—
Drepane africana	67	—	—	—	—
Scoliodon terrae-novae	53	—	—	—	—
**Hemiconiatus guttifer*	47	—	—	—	—
Balistes forcipatus	27	—	—	—	—
Galeoides decadactylus	33	—	—	—	—
Lethrinus atlanticus	33	31	—	—	—
**Ostracion tricornis*	40	54	—	—	—
Lutjanus maltzani	47	38	33	—	—
Pagrus ehrenbergii	60	77	67	36	—
Lutjanus guineensis	—	38	—	—	—
Epinephalus aeneus	—	54	58	—	—
Cephalacanthus volitans	—	46	33	—	—
Pagellus sp. aff. *P. erythrinus*	—	31	75	82	40
Otopercs aurita	—	—	50	27	—
Sciar crumenophthalis	—	—	25	27	—
**Lepidotrigla cadmani*	—	—	42	64	80
Priacanthus arenatus	—	—	—	45	—
Umbrina canariensis	—	—	—	27	40
Sciaena sp.	—	—	—	25	80
Denlex congoensis	—	—	—	36	60
**Antigonia capros*	—	—	—	—	60
Smaris macrophthalmus	—	—	—	—	60
Scomber colias	—	—	—	—	60
**Trigla lyra*	—	—	—	—	40
Hypoclydonia bella	—	—	—	—	40
Families, etc.					
Ephippidae	40	—	—	—	—
Drepanidae	67	—	—	—	—
Lutjanidae	47	54	31	—	—
Serranidae	—	—	54	—	—
Sciaenidae	47	—	—	36	60
Pomadasidae	47	38	62	30	—
Sparidae	60	77	92	100	80
Flatfish	—	46	33	27	40
Skates and rays	60	77	—	64	40
Sharks	80	—	83	45	40

* Non-marketable species

whether the same description will hold for the greater part at least of the West African shelf. An extensive trawling and hydrographic survey of the region, from Dakar to the Cameroons, was made by the *Cape St. Mary* during 1952–53. The results of this survey, though not very detailed, tend to support such a generalization. The eurythermal and euryhaline fish fauna inshore of the 10-fathom line suggests that the water of this region is subject to fluctuations in temperature and salinity, probably as a result of heavy rainfall and freshwater run-off from the land. It is interesting to note that both the extent of this region and the rainfall are smaller in the Gold Coast than in French Guinea. The inshore region of French Guinea (Postel[7]) and indeed of much of the West African coast (unpublished results of the *Cape St. Mary* cruises, 1952–53) is greatly affected in salinity and temperature in this way. Currents and upwelling may be important modifying factors because of their mixing action. In their absence, stratification with its usual adverse affect on the fauna would tend to occur. It is possible, therefore, that heavy rainfall and freshwater run-off from the land are important factors, though not necessarily the only factors, in determining the nature and distribution of the inshore fish fauna of West Africa.

I wish to thank the Director of this Institute for permission to publish this work. A full account will be published elsewhere.

[1] Postel, E., *Cons. Internat. Explor. Mer, Rapp. et Proc.-Verb.*, 137, 10 (1955).
[2] Whiteleather, R. T., and Brown, H. H., "An Experimental Fishery Survey in Trinidad, Tobago and British Guiana" (Anglo-American Caribbean Commission, U.S. Government Printing Office, Washington, 1945).
[3] Houston, T. W., Technical Paper No. 2, Division of Fisheries, Commonwealth Sci. Indust. Res. Organization, Australia (1954).
[4] Fairbridge, W. S., *J. Coun. Sci. Indust. Res., Australia*, 21, 75 (1948).
[5] Hefford, A. E., "Report of the Work of the Steam Trawler, *William Carrick*", Dept. of Industries, Government of Bombay (Government Central Press, Bombay, 1923).
[6] Hart, T. J., Discovery Reports, 23, 223 (1946).
[7] Postel, E., *Cons. Internat. Explor. Mer, Rapp. et Proc.-Verb.*, 137, 5 (1955).

MODIFICATIONS OF MICROSCOPIC TISSUE REACTIONS TO HOMOLOGOUS GRAFTS IN RABBIT PARABIONTS

By Dr. RICHARD H. ANDRESEN, Dr. CLARENCE W. MONROE, DOROTHY A. MADDEN and Dr. GEORGE M. HASS

Rush Departments of Pathology and Surgical Research, Presbyterian Hospital, Chicago, Illinois, in affiliation with the University of Illinois College of Medicine

PREVIOUS investigations using musculofascial transplants have led to an accurate means for distinguishing between autografts and homografts by a microscopic study of the tissue reactions at the site of grafting. Though the musculofascial transplants did not survive permanently, they were suitable for our purposes for the following reasons: (1) resection and implantation could be done under strict aseptic conditions; (2) the grafts were simple in structure; (3) tissue for grafting was available in large amounts; (4) the transplants were sufficiently uniform so that they could be fractionated by available chemical methods without much variation in the composition of the fractions.

New Zealand rabbits of the same source and strain were used. Autografts and homografts of erector spinæ muscle were regularly made to sites comparable with those from which the grafts were resected[1]. After the first week, transplants were well healed in place. Thereafter, gradual organization and resorption ordinarily occurred so that by the end of three or four weeks most of each type of transplant had disappeared. On this account, microscopic study of host–graft reactions at sites of transplantation were most satisfactory at the end of the second week. At this time autologous transplants were well healed in place. A bursal space had formed immediately over the transplant and just beneath the superficial fascia of the skin of the back overlying the transplantation site. A pannus of vascularized granulation tissue regularly grew over the fascia of the transplant forming the base of the bursal space. The fascia of the transplant was œdematous and thickened, presumably due to retraction. Vascular channels arising from the host and growing along with the pannus penetrated the fascia perpendicularly and ramified in the musculofascial zone. As vascularization occurred, the musculofascial zone became broad and filled in with a plexus of small vascular channels supported by proliferating fibroblasts and newly formed collagenous fibrils, which occupied the zone vacated by the resorption of subfascial skeletal muscle. Infiltration of inflammatory cells was negligible in the autologous grafts.

Microscopic study of homologous musculofascial transplants, two weeks of age, showed that patterns of degeneration and resorption of muscle with organization of the musculofascial zone began in much the same way as in the autologous transplants. However, there were factors in the host–homograft relationship which interfered with the successful completion of the autologous pattern of resorption and organization. These factors led to a massive infiltration of lymphoid cells into the musculofascial zone. This infiltration was accompanied by a variable amount of angiitis affecting small vessels within the pannus, fascia and musculofascial zone of the transplant. These microscopic findings allowed us to distinguish accurately between homologous and autologous transplants.

Although the above response which was designated as the basic homologous host–graft tissue reaction was characteristic of the microscopic response to an initial transplant, the nature of this reaction changed

when multiple, successive transplants of musculofascial tissues to the same host were made from the same donor[1]. This change consisted of an acute thrombotic necrotizing reaction with hæmorrhage involving especially the musculofascial zone of the second and third transplants in succession. In connexion with this acute reaction, there was conspicuous impairment of fibroblastic proliferation and formation of collagen. Infiltration of lymphoid cells was also reduced, and most cells in the musculofascial zone were eosinophiles and polymorphonuclear leukocytes. This form of reaction was designated as an acute 'sensitized' homologous host–graft tissue reaction.

In an attempt to discover factors responsible for the basic and sensitized homologous host–graft tissue interactions, it seemed desirable to study the effect on the interactions of exposure of musculofascial transplants to X-irradiation and thermal treatment *in vitro* prior to transplantation[2]. These studies disclosed that by sufficient exposure either to X-irradiation at high and low temperatures, grafts could be so modified that the microscopic host–autograft and host–homograft interactions were identical. The observations also led to the conclusion that the customary host–graft interactions appeared to depend to a large extent upon the mutual admixture of proliferating vascularized mesenchymal tissues of the graft and the host. Anything which impaired the rate of proliferation or the admixture of the tissues seemed to impair the intensity of the homologous or autologous reactions. Indeed, the classical autologous and homologous reactions both disappeared when the thermal and irradiation treatments were sufficient to eliminate the stimulus to admixture, despite prolonged persistence of the grafts in the host.

In view of the apparent significance of the activity of the cells of the host, as well as those of the graft, it was decided to study the reactions which occurred between surgically united homologous tissues, each retaining its own blood supply. For this purpose, rabbits were joined surgically by the ears[3]. Within three to four days after surgical anastomosis, continuity of circulation between the two animals was demonstrated and the dermal epithelium of the parabionts was also united. Furthermore, collagen and reticulum were mutually deposited at the site of anastomosis so that a firm connective-tissue union between the two ears was established. After seven to thirteen days, it was no longer possible to demonstrate a cross-circulation; and its failure to persist was correlated with the development of an inflammatory reaction along the plane of anastomosis of the tissues. During this time the united dermal epithelial surfaces of the parabionts also became discontinuous. The infiltration of lymphoid cells and the angiitic reactions on each side of the plane of anastomosis persisted almost unchanged for as long as five months in some animals even though the mesenchymal tissues remained firmly united by persistence of collagen and reticulum which had been deposited during the early stages of healing[4]. The question arose as to whether the persistent collagen and reticulum belonged specifically to each animal or whether the intercellular products resistant to the incompatibility reaction were a third compatible form of tissue developed by the joint activities of cells and fluid substrates of the two animals.

With the experience of repeated musculofascial grafting and the resultant sensitized reactions in mind, pairs of parabionts were separated and then reunited in parabiosis by surgical anastomosis of the two other ears. In these instances the aural junctions failed to heal and separated spontaneously on the fifth or sixth day after anastomosis. This was regarded as another form of sensitized homologous incompatibility reaction, for when a parabiont was united to a control animal which had never been in parabiosis, healing of the ears occurred in much the same way as between two control animals. These observations indicated that it might be profitable to make a microscopic study of the host–graft interactions to musculofascial grafts following parabiosis rather than to use inbred strains of animals in successful parabiosis, as had been done in a study of renal grafts[5]. Therefore, rabbits were united in parabiosis for periods of two to three weeks and then separated from one another. One group was reunited in parabiosis a second time and then separated a second time. Another group was placed in parabiosis but once. Animals in both groups were then cross-transplanted with musculofascial grafts derived from their respective parabiotic twins. The grafts and adjacent tissues showed two types of host–graft interactions which were about equally distributed between the two groups of parabionts. The first type consisted of a fibro-collagenous encapsulation of the transplant with excellent preservation of the architecture of the graft. There was no penetration of the graft by vascularized mesenchyme from the host.

The second type of reaction was similar to the first, except that vascular penetration of the graft by vessels arising in the tissues of the host occurred, often developing a strange angiomatous pattern of large patent channels which ramified throughout the fascia and subjacent musculofascial zone of the transplant. Despite the conspicuous vascularization, the musculofascial zone of the transplant was not materially modified because fibroblastic proliferation, collagen formation and inflammatory reactions did not occur. In other words, the characteristic features of either the basic or sensitized homologous host–graft interactions did not develop. The parabiotic response was very specific and was readily reproduced between parabiotic twins after separation for as long as ninety days. However, if cross-transplants were made between parabionts which had never been joined together, the incidence of the parabiotic type of host–graft interaction was reduced about one-half. When the musculofascial transplants to parabionts were obtained from animals which had never been in parabiosis or exposed to grafting procedures of any kind, the types of host–graft interactions at the site of transplantation in the parabiont were variable and unpredictable. These studies, however, did show that the parabionts retained the capacity to react with the classical homologous types of response to tissues derived from animals which had never been in parabiosis or subjected to free grafting procedures.

Further permutations of musculofascial grafts between control and post-parabiotic animals have indicated that about one-third of the control rabbit population falls into a class characterized as follows. If the parabiont reacted to the transplant from the control animal with a parabiotic type of reaction, transplants to the control animal from the parabiont were accepted by the control animal with an autologous-like tissue reaction. In other words, the parabiont's musculofascial tissues were almost as acceptable to the control animal as similar grafts

from the control animal into itself. This observation led us to consider the possibility of carrying out successful homologous transplants with the assumption that by use of post-parabionts and non-parabionts a beginning has been made in developing a means for placing genetically impure strains of rabbits in groups according to their tissue types.

This study was supported by funds from the National Heart Institute, National Institutes of Health (*H*-1630), the Muscular Dystrophy Associations of America, Inc., and the Otho S. A. Sprague Memorial Institute.

[1] Andresen, R. H., Monroe, C. W., and Hass, G. M., *J. Exp. Med.*, **95**, 509 (1952).

[2] Andresen, R. H., Monroe, C. W., and Hass, G. M., *Fed. Proc.*, **14**, No. 1 (March 1955).

[3] Monroe, C. W., Andresen, R. H., and Hass, G. M., *Plastic and Reconstructive Surgery*, **11**, No. 1 (January 1953).

[4] Andresen, R. H., Monroe, C. W., and Hass, G. M., *Amer. Med. Assoc. Arch. Path.*, **58**, 455 (1954).

[5] Kamrin, B. B., and Kamrin, R. P., *Anat. Rec.*, **122**, 223 (1955).

METHOD OF MOLECULAR FIELDS

By T. M. DUNN

William Ramsay and Ralph Forster Laboratories, University College, Gower Street, London, W.C.1

THE applications of ligand field (crystal field) theory have brought about a great deal of clarification in the realm of the magnetism, structure and spectra of inorganic transition metal complexes, mainly of the spin-free type. In this method the inorganic ion is placed in an electric field of suitable symmetry and the changes in the free ion energy-levels resulting from the Stark splitting of the free space five-fold degeneracy of the *d*-electrons are calculated.

The Stark field is supplied by a system of negative ions or by dipoles oriented with negative poles towards the positive ion, and under the perturbation thus caused the 'non-bonding' *d*-electrons of the ion assume the position of lowest potential. In a cubic field this perturbation causes a split of the *d*-levels into the now familiar essentially non(σ)bonding $d\varepsilon$ triplet, which decreases in energy, and the essentially non- or anti-bonding $d\gamma$ degenerate pair, which are shifted to higher energies.

It is important to point out that this general type of approach can be applied with equal success to elements in the periodic table prior to the first transition series, where the spin-paired behaviour is the rule rather than the exception. In its application to this class of compounds the term ligand, or crystal field, theory has little significance and is rather misleading so that it is suggested that the theory be called the method of molecular fields.

The essential difference between the approach in this case and in the ligand field theory consists in the use of positive charges as the origin of the perturbing Stark field. Positive charges are used because any atom in a spin-paired molecule acts towards its near neighbour as a source of positive potential, attracting electrons towards itself rather than repelling them as in the ligand field theory.

Consider the case of acetylene. As a first approximation we may consider a carbon atom at the origin of a set of Cartesian co-ordinates with unit positive charges at $(0,0,a)$ and $(0,0,-a)$, that is, along the *z*-axis.

Since no electric field can remove a Kramers two-fold degeneracy it is only the $2p$ orbitals which split in the linear Stark fields. This triply degenerate $2p$-level splits to give a low-lying singlet and a high-lying doublet. This splitting is indicated in Fig. 1.

It is easy to see even intuitively that the p_z orbital is the one depressed to lower energies and so its

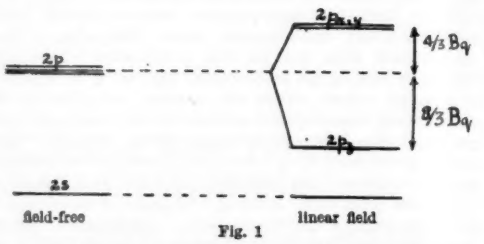


Fig. 1

energy becomes much more compatible with the $2s$ atomic orbital.

The four electrons can now be fed into the levels and the configuration will depend upon the magnitude of the *p* splitting. Thus, if the splitting is large, then the configuration will be (ignoring the $1s$ electrons) $2s^2\ 2p_z^2$, giving a $^1\Sigma_g^+$ state.

This can also be shown for the states of the free carbon atom subjected to a very strong Stark field. The atomic states arising from the configuration s^2p^2, namely, ^3P, ^1D and ^1S, are split by the field as follows. The lowest atomic state ^3P is split into a pair of states $^3\Sigma_g^-$ and $^3\Pi_g$ (in $D_{\infty h}$ notation), ^1D gives rise to a low-lying $^1\Sigma_g^+(1)$ state and two higher lying states $^1\Pi_g$, $^1\Delta_g$, and the ^1S is not split but is now designated $^1\Sigma_g^+(2)$ (Fig. 2).

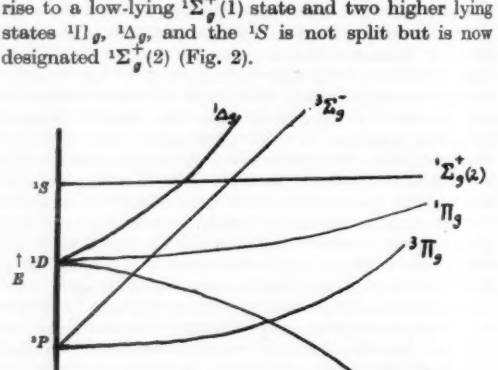


Fig. 2

If the field is not too strong then the $^3\Pi_g$ state will lie lowest and the configuration will be $2s^2\ 2p_z\ 2p_{x,y}$. In this case the excitation of an s electron to the $p_{x,y}$ shell will produce, among other configurations, a carbon atom with four parallel spins, the difference from the usual sp^3 configuration being that the p orbitals are no longer equivalent.

The solution of a perturbation secular determinant for the s- and p_z-levels will yield the familiar sp digonal or linear hybrid orbitals and these may be occupied by replacing one of the positive charges by a hydrogen atom with opposite electron spin to the bonding sp electron. The other positive charge may be replaced by a similarly constituted CH group also with opposite sp bond electron spin. Provided also that the p_xp_y electrons on the two CH groups are opposite in spin, then the two π bonds will form and complete the acetylene molecule.

The analogous case of ethylene can be similarly considered by using a plane trigonal array of positive charges in the x,y plane, when it is easily shown that the p_x and p_y energies fall and the p_z rises as in Fig. 3.

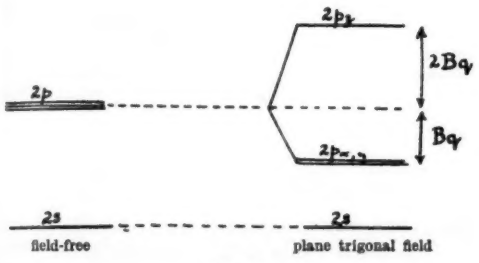


Fig. 3

The further splitting of the levels during 'covalent' or spin-paired molecule formation has been ignored in this preliminary discussion but can be included without altering the final results. The theory also shows that in the case of the tetrahedral carbon atom there is no splitting of the p shell and so all p orbitals are equivalent.

One important feature of this description is an added reason for the relative success of the σ–π electron approximation. The Huckel approximation thus owes part of its success to the differences in energy of the σ and π shells which develop under the influence of the Stark perturbation as well as the differences in symmetry of the shells, since electrostatic perturbations will be less effective in mixing orbitals with greatly differing energies.

In π electron calculations it is not usual to minimize the energy with respect to the effective potential of the carbon nucleus for each problem, and the value of Z^* usually used is that due to either Zener (3·18) or the Slater value (3·25). The above considerations suggest that this value is too high and that a lower value would lead to more correct estimates of the π energy in the absence of a complete calculation.

Bayliss directed attention to this fact[1] in 1949 when he pointed out that if the π energy of butadiene was minimized with respect to the effective potential field of the carbon atom using a free electron model then the value of Z^* was 1·2. This is perhaps too low an estimate but shows the correct trend. The molecular field correction to the Z^* value for π calculations is reduced somewhat when the effect of resonance splitting during molecule formation is taken into account.

The splitting magnitude to be expected for the p shell may be calculated theoretically in terms of a parameter Bq (analogous to the parameter Dq in ligand field theory), which can also be calculated theoretically. It seems more desirable at first, however, to consider Bq as an adjustable parameter which once obtained can be applied to other cases of interest. Reasonable estimates of Bq result in a value of the order of 1 eV., thus giving an overall split in the acetylene p energy-levels of about 3 eV.

The method of molecular fields is not limited in its application to first- and second-row elements but can be applied to the transition series of metal spin-paired complexes, as an example readily shows.

In the case of octahedral spin-paired complexes such as potassium ferricyanide the situation is that instead of negative charges surrounding the central ion at points along the co-ordinate axes, the perturbing potential is assumed to be, in addition, a *pair* of positive charges situated above and below the ligand co-ordinates. This is simply because if CN is used as ligand (*not* CN^-) it can be reasonably supposed that the effect of the positive ion on the ligand will be to lower the energy of the $x\sigma$ antibonding orbital relative to the $w\pi$, and this can be regarded as leading to a hole in the π shell with a completed σ shell. This results in a tendency for the $d\varepsilon$ shell to become stabilized by two methods which cannot be strictly resolved: (1) The attraction of $d\varepsilon$ electrons into the π shell of the ligand; (2) the repulsion of the $d\gamma$ electrons by the lone σ pair of the CN group.

Thus, in the case of these spin-paired complexes the push-pull operation of these two factors results in a very large splitting compared to the sp n-free complexes.

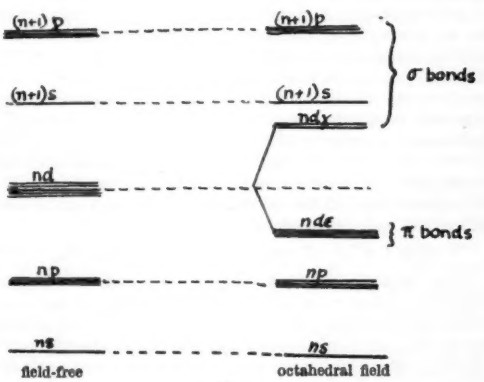


Fig. 4

In this way the $nd\gamma$ orbitals of the central ion become comparable in energy with the $(n+1)s$ and $(n+1)$ patomic orbitals of the ion as well as with the σ lone pairs of the ligands and so effective overlap can occur. The complete scheme is shown in Fig. 4 and shows one reason why the calculations of Craig *et al.*[2] showed a disappointingly small overlap of nd with $(n+1)s$ and $(n+1)p$.

The full details of the calculations, together with wider applications of the theory, will be published shortly. [Sept. 26

[1] Bayliss, *J. Chem. Phys.*, 17, 1352 (1949).
[2] Craig, Maccoll, Nyholm, Orgel and Sutton, *J. Chem. Soc.*, 332 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Microchemical Method for the Preparation of Sources of Actinium and Europium for β-Ray Spectroscopy

The preparation of adequate sources is one of the most critical problems in β-ray spectroscopy. In general, chemical means alone have not proved sufficient. Crystal formation and the tendency for a non-uniform distribution of the source material make the effective thickness of the source considerable, even in cases where the amount of material is small enough to make the average thickness negligible. In addition, it is often difficult to concentrate the activity on a sufficiently small area of the supporting foil. For these reasons, use has been made of evaporation *in vacuo*, of electrolysis, and of isotope separators.

The method to be described here is nevertheless a purely chemical one. It has the advantage of high efficiency, and potentially the advantage of general applicability. We believe that the procedure described for actinium and europium can be applied with little modification to the thirty lanthanides and actinides. We also see no reason why in principle the procedure cannot be utilized with the same or other resins to concentrate many of the seventy remaining atomic species, provided they are in an essentially carrier-free form.

The basic principle is the concentration of the activity on a very small ion-exchange column and the subsequent elution with a strong eluting agent to get out the activity in a very small volume.

Actinium-228, a 6-hr. beta minus emitter, is used as an example in the procedure which follows. The initial actinium sample (volume 0·3 c.c., activity 10 μc.) is a carrier-free solution of 5 per cent ammonium citrate (*p*H 4·3) obtained by ion-exchange separation of actinium-228 from its long-lived mother substance, radium-228, the ion exchanger being 'Dowex 50'. Concentrated hydrochloric acid is added to adjust the *p*H to about 1; that is, the citric acid is largely brought to its undissociated form and hence actinium will exist as Ac^{3+}:

$$Ac(H\,Ctr.)_3^- + 4H^+ \rightarrow Ac^{3+} + 2\,H_3Ctr. \quad (1)$$

The sample is now forced through a 'Dowex 50-*X*12' column which has previously been conditioned in order to bring it either to the hydrogen or to the ammonia form. Although the particle-size of the resin may be varied within limits, the particles of the resin used in most of our experiments have a settling rate in water of 0·3–0·5 cm./min. The column dimensions are 0·03 mm.² by 13 mm., the free column volume thus being 0·2 μl. Even when the actinium is forced through at a flow-rate in excess of 10 μl./min., more than 80 per cent of the activity remains with the resin (*R* denotes resin skeleton):

$$Ac^{3+} + 3RSO_3NH_4 \rightarrow (RSO_3)_3Ac + 3\,NH_4^+ \quad (2)$$

Finally, the column is eluted with a 1 *M* ammonium lactate solution (*p*H 5–7):

$$(RSO_3)_3\,Ac + 3\,Lact.^- \rightarrow 3RSO_3^- + Ac\,(Lact.)_3 \quad (3)$$

The activity comes out with the front of the eluent in a volume of 0·5–2 μl. This small volume is picked up on a 150-μgm./cm.² aluminium foil and dried under an infra-red lamp. The foil, which has previously been fastened on a 0·5-mm. metal frame with the aid of a minute amount of 'Zapon' lacquer, is now transferred to a crucible and heated with a Bunsen burner. The ammonium lactate evaporates leaving the activity on an area of 1–3 mm.² in a very thin and quite uniform layer which is often invisible. The overall yield is, apart from decay, 30–80 per cent. The procedure takes 2–3 hr. The effective thickness of the source has been estimated from the resolution of internal conversion lines in the low-energy region (< 50 keV.) (see Fig. 1). Comparison with the internal-conversion lines resulting from isotope-separated activities in which the ions have been driven into the aluminium backing to a depth of approximately 5 μgm./cm.² indicates that equally thin sources can be obtained with the present method.

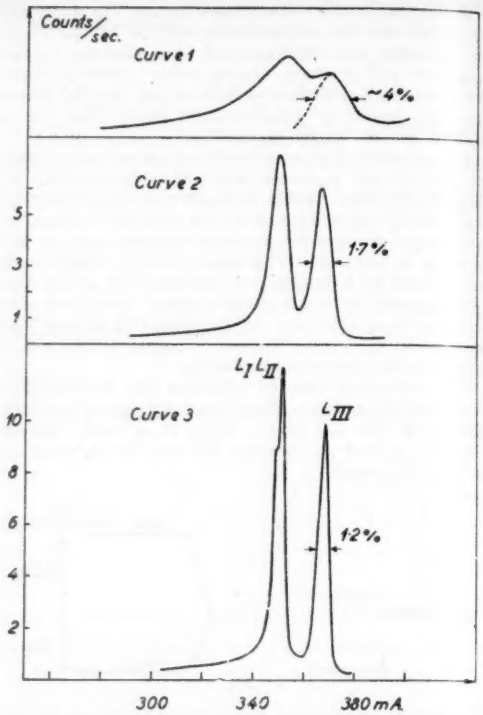


Fig. 1. $L_I L_{II}$ (37 keV.) and L_{III} (41 keV.) conversion lines of the 57-keV. *E2* transition in thorium-228 measured in a β-ray spectrometer with sources of different thickness

The most serious difficulty in connexion with the method arises from the fact that impurities will also be concentrated by processes (1), (2), and (3). This is true for alkaline earths, particularly calcium and magnesium, and third-group metals, particularly aluminium. The ion-exchange separation which precedes the concentration procedure just described is not specifically worked out in order to eliminate impurities. If as an example we assume an ash content of 10 p.p.m. by weight in the initial 0·3-c.c. sample, this results in a mean thickness of 100 μgm./cm.² when spread over a 3-mm.² area. The effective thickness would presumably be considerably greater (Fig. 1, curve 1).

We have overcome these difficulties by using 'Dowex-50' ion-exchanged reagents. This greatly

decreases the thickness of source while maintaining a yield as high as 80 per cent (Fig. 1, curve 2).

A further improvement can be achieved by using a weaker eluent in process (3). If, instead of a 1 *M* ammonium lactate solution, one uses a molarity of 0·7, an actual separation takes place on the micro-column between the ash and the activity. However, this happens at the expense of the yield, which decreases to 30–50 per cent, apart from decay. Also the time required for preparation of the source is increased to three hours. Curve 3 (Fig. 1) shows the maximum resolution obtained from a source made in this way.

The procedure has also been successfully applied to the preparation of a source of europium.

We wish to thank Prof. Niels Bohr for the ideal working conditions in his Institute, Prof. I. Perlman for discussions and for some of the graded resin used in these experiments, and Prof. K. Linderstrøm-Lang and Mr. Sigurd Olaf Nielsen for valuable suggestions with respect to microtechniques.

S. Bjørnholm
O. B. Nielsen
R. K. Sheline*

Institute for Theoretical Physics,
University of Copenhagen.
Aug. 28.

* Guggenheim and Fulbright Scholar on leave from the Chemistry Department, Florida State University, Tallahassee, Fla.

High-Resolution Microwave Zeeman Spectrometer

A HIGH-RESOLUTION microwave Zeeman spectrometer has been constructed, and measurements of molecular magnetic moments are now being made on a series of molecules.

The apparatus is similar in principle to that described by Jen[1]. A resonant-cavity absorption cell is located between the poles of a large electromagnet. A *Q*-band klystron the reflector of which is modulated simultaneously by a 25-c./s. saw-tooth voltage and a 100-kc./s. sine-wave supplies power to the cavity at a frequency of ~ 35,000 mc./s. The power reflected from the cavity is detected by a silicon crystal, amplified and displayed on one trace of a double-beam oscilloscope, the time-base of which is the source of the 25 c./s. saw-tooth modulation.

The gas under investigation is let into the cavity at a pressure of a few microns, and when the klystron frequency and modulation index, the power-level and the crystal detector unit have all been correctly adjusted, the appropriate rotational absorption line is displayed (Fig. 1). This line splits into two (or more) components when the magnetic field is applied (Fig. 2).

To facilitate the initial adjustments a 3-metre wave-guide absorption cell is simultaneously employed. The signal from the crystal at the output end of this cell can be switched on to the first oscilloscope trace in place of the cavity-resonator signal. Power from a second klystron the reflector of which is modulated at a variable radio frequency of ~ 1 Mc./s. is mixed with that of the first, and the difference-frequency spectrum detected by a 30-mc./s. frequency-modulated receiver. The output of this receiver is applied to the other beam of the oscilloscope, and consists of a ladder of sharp marker pulses the spacing of which, on a frequency base, is the modulation frequency of the second klystron. Frequency difference of lines displayed on the first oscilloscope trace can thus be measured by superimposing the markers displayed on the second trace (Fig. 3).

The wave-guide cell and the cavity cell can be heated or cooled to 'dry-ice' temperature, and in this way the intensities of the absorption lines increased.

For the $J,K = 13,13$ line in the ammonia inversion spectrum, we have verified that the temperature dependence of the line intensity is of the expected form $\alpha T \equiv A \exp(-B/T)$, where α is the line intensity, T the absolute temperature and A and B constants for the line[2].

The magnetic field is measured with a nuclear magnetic-resonance field meter, which is also used for field stabilization.

Thus the Zeeman effect is measured in terms of two radio frequencies—that of the signal generator modulating the second klystron, which measures the Zeeman splitting, and that of the nuclear magnetic resonance oscillator, which measures the magnetic field. Both frequencies are calibrated in terms of an accurate crystal-controlled wave-meter. The spectrometer has been used for measuring the Zeeman splitting (σ-transitions) of four lines in the $^{14}NH_3$ inversion spectrum, namely:

$J,K = 12,12$ at 31,424·97 Mc./s.
$J,K = 13,13$ at 33,156·95 Mc./s.
$J,K = 14,14$ at 35,134·44 Mc./s.
$J,K = 15,15$ at 37,385·18 Mc./s.

Because of the large quantum numbers, the hyperfine structure due to the ^{14}N quadrupole coupling cannot be resolved, and the Zeeman splitting yields the molecular magnetic moment directly.

The Zeeman splitting of these lines is linear up to the highest magnetic fields so far applied, namely, 0·5 weber/metre^2.

The same molecular g-factor is obtained for all four of these lines, within the limits of error of approximately $\pm$ 2 per cent.

The mean of all the measurements on the four lines is $g_{mol.} = 0{\cdot}490 \pm 0{\cdot}008$. With the values of $g_{xx} = 0{\cdot}560$ and $g_{zz} = 0{\cdot}484$ obtained by Eshbach and Strandberg[3] from measurements of seven ammonia lines in the region $J,K = 3,1$–$6,6$, an effective molecular g-factor, $g_{mol.} = 0{\cdot}490 \pm 0{\cdot}007$, should be expected for the J-values used in our measurements, provided that g_{zz} and g_{zz} are independent of J.

The close agreement shows that this condition holds over the whole range of rotational-levels so far

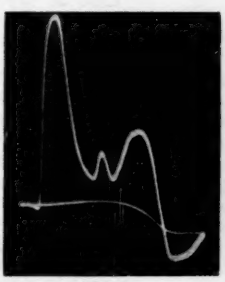


Fig. 1

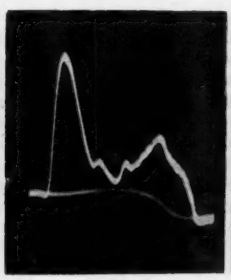


Fig. 2

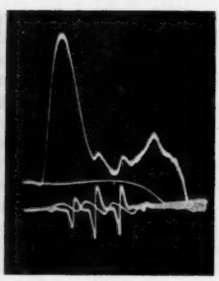


Fig. 3

observed, and implies that there is no significant dependence of valence electron 'slip' upon the angular momentum of the molecule.

From the Zeeman splitting of the $K = 1$ component of the $J = 1 \rightarrow 2$ doublet in the spectrum of CH_3CCH, we have obtained $g_{zz} = 0{\cdot}30 \pm 0{\cdot}02$, in close agreement with the values found by Cox and Gordy[4] from the $J = 2 \rightarrow 3$ and $J = 3 \rightarrow 4$ transitions, namely, $g_{zz} = 0{\cdot}298 \pm 0{\cdot}006$. In agreement with Cox and Gordy, we find no observable splitting of the $K = 0$ component, that is, $g_{xx} \approx 0$.

R. W. R. Hoisington
C. Kellner
M. J. Pentz
Imperial College of Science and Technology,
South Kensington,
London, S.W.7.

[1] Jen, C. K., *Phys. Rev.*, **74**, 1396 (1948); **76**, 1494 (1949).
[2] Nat. Bur. Stand. Circ. No. 518.
[3] Eshbach, J. R., and Strandberg, M. W. P., *Phys. Rev.*, **85**, 24 (1952).
[4] Cox, J. T., and Gordy, W., *Phys. Rev.*, **101**, 1298 (1956).

Combustion of Methane

It is known that the most reactive mixture of methane and oxygen is $2CH_4 + O_2$, the most easily detonated $CH_4 + O_2$ and the most inflammable $CH_4 + 2O_2$. Methane is not unique in this respect because, as Coward and Payman[1] have pointed out, the most reactive mixtures of each of the simple paraffin hydrocarbons with oxygen are those containing hydrocarbon and oxygen in the molecular proportion 2 : 1; yet none of these mixtures can propagate flame at normal temperature and pressure. An interpretation of these curious facts may be suggested on the following lines.

The 2 : 1 ratio of methane to oxygen in the most reactive mixture implies that the determining step in the slow combustion of methane involves two molecules of methane and one of oxygen. (The word step is used in the thermodynamic, not the kinetic, sense. That is, we are concerned with equilibrium states, not the route from one to the other.) The slowness of the reaction is probably indicative of the low frequency of three-body collisions involving specifically two molecules of methane and one of oxygen. Its easy initiation, on the other hand, argues that relatively little energy is needed to disturb the equilibrium of this tri-molecular grouping and enable it to pass into the next equilibrium state. The simplest rearrangement would appear to be the splitting of the oxygen molecule, which must always happen, and the assimilation of one oxygen atom by each methane molecule. Thus,

$$CH_4 + (O + O) + CH_4 \rightarrow 2CH_3OH + 78 \text{ k.cal.}$$

This initial formation of methanol fits in with Bone's[2] scheme for the slow oxidation of methane.

The fact that the equimolecular mixture of methane and oxygen is the most readily detonated suggests that the initial step here is a two-body collision process involving one molecule of each kind. The products of the detonation reaction[3] are $CO + H_2 + H_2O$ and so it may be inferred that the determining step in the detonation of methane–oxygen mixtures can be represented thus:

$$\begin{aligned} CH_4 + O_2 &\rightarrow (C + H_2 + H_2) + (O + O) \\ &\rightarrow CO + H_2 + H_2O \qquad + 77 \text{ k.cal.} \end{aligned}$$

Hence the methane molecule also divides and, since three new molecules are formed, it must divide into three. This implies that much more energy per mole is required to trigger detonation than slow combustion.

The optimum proportions in the case of deflagration seem at first sight to suggest a three-body collision process involving one molecule of methane and two of oxygen; but this is statistically improbable in view of the speed of this reaction. The alternative would appear to be two successive bi-molecular encounters involving first one oxygen molecule and then the other. The first event, however, must be distinguished from detonation and, since deflagration is easier to initiate, it is reasonable to suppose that, in this case, the methane molecule divides into two instead of three. In other words, the methane molecule is stripped of one hydrogen pair instead of two. This may be represented:

$$\begin{aligned} CH_4 + O_2 &\rightarrow (CH_2 + H_2) + (O + O) \\ &\rightarrow CH_2O + H_2O \qquad + 78 \text{ k.cal.} \end{aligned}$$

followed by:

$$\begin{aligned} CH_2O + O_2 &\rightarrow (CO + H_2) + (O + O) \\ &\rightarrow CO_2 + H_2O \qquad + 135 \text{ k.cal.} \end{aligned}$$

The second stage of the reaction will, of course, benefit from the energy released in the first and may require no other help to initiate it, in which case the second stage follows spontaneously. Thus the activation energy of the whole process may correspond to that of the first stage whereas the total energy released is the sum of the two, namely, 213 kcal. per mole of methane.

The interesting point emerges that the energy released in detonation may represent only part of the total energy available and may in fact be much less than that generated by deflagration. The violence of the detonation process thus appears to be due more to the speed of the reaction than to the amount of energy released, and this depends on the statistical frequency of encounters between the appropriate species. This probably explains why the maximum detonation velocity in mixtures of methane and oxygen occurs not in the stoichiometric but in the equimolecular mixture.

Elwyn Jones
Research Department,
I.C.I. (Nobel Division),
Stevenston,
Ayrshire.
July 20.

[1] Coward, H. F., and Payman, W., *Chem. Rev.*, **21**, 539 (1937).
[2] Bone, W. A., and Townend, D. T. A., "Flame and Combustion in Gases" (Longman, 1927).

Use of Irradiated Polymers as Initiators of Polymerizations

It has been demonstrated by physical methods[1] that in some polymers free radicals are formed during exposure to high-energy radiations, and that in some cases they can survive for long periods. These radicals can also be detected by chemical methods, and under suitable conditions they can be used for initiating the polymerization of typical monomers to give graft co-polymers[2]. In the preliminary work described here the formation of graft co-polymers has been detected by using a monomer labelled with carbon-14; by this means it has been possible to determine accurately very small weights of grafted material.

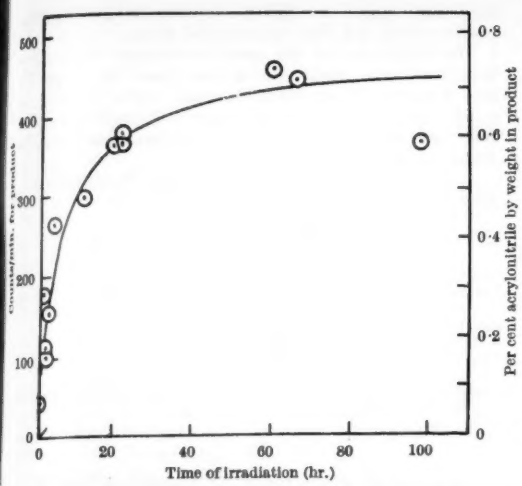


Fig. 1. The variation in activity and composition of the polymer with the time of irradiation, for 60 min. exposure to ^{14}C-acrylonitrile vapour at a pressure of 78–79 mm. mercury; samples at 18·5°–19·5°C. during exposure

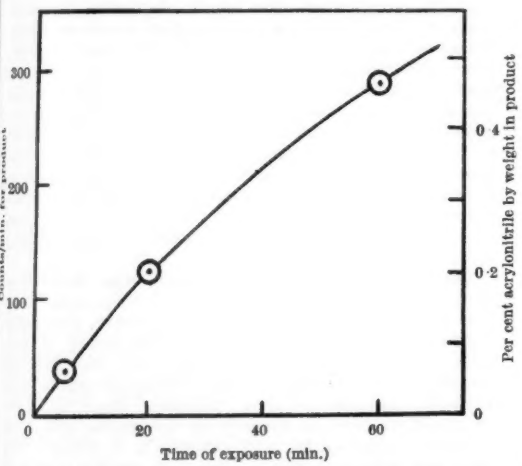


Fig. 2. The variation in activity and composition of the polymer with the length of exposure to ^{14}C-acrylonitrile vapour at 73·5 mm. mercury, for irradiation of 17 hr.; samples at 19·5° C. during exposure to monomer

Polymers, for example, polystyrene, polyacrylonitrile, 'Terylene' and 'Nylon', are irradiated in vacuum with γ-rays from a cobalt-60 source (nominally 100 curies). The irradiated polymers are afterwards exposed to the vapour of ^{14}C-acrylonitrile. After the residual vapour has been pumped off in high vacuum, the specimens are assayed by gas-counting. In some cases, as much as 10 per cent by weight of acrylonitrile is introduced into the polymer. Only a negligible amount of vapour is taken up by a sample which has not been irradiated. For example, two samples of powdered polyacrylonitrile were exposed to the vapour of ^{14}C-acrylonitrile at 78 mm. mercury for 2¼ hr.; the first had previously been irradiated for 18 hr., but the second had not been exposed to γ-rays. The first sample gave a counting-rate of 6,350 counts/min. whereas the second gave only 81 counts/min.; the counting-rate for polymer prepared directly from the labelled monomer was 59,300 counts/min.

With 'Nylon', the same results are obtained when the specimen is exposed to ^{14}C-acrylonitrile vapour 100 hr. after irradiation as when there is only a short interval after irradiation. If air is admitted to the specimen after irradiation, its activity is almost completely destroyed.

To obtain reproducible results, it is necessary to control carefully a number of factors, namely: (1) the physical state of the polymer, in particular its specific surface area; (2) the irradiation dose; (3) the time of contact with vapour of labelled monomer; (4) the pressure of the monomer vapour; (5) the temperature of the specimen during exposure to monomer.

Experiments with 15-denier monofil 'Nylon' yarn (kindly supplied by British Nylon Spinners, Ltd.) have shown that the quantity of ^{14}C-polyacrylonitrile formed increases with irradiation dose but approaches a limiting value (Fig. 1). With samples of 'Nylon' given the same dose, the amount of monomer taken up increases with the time of exposure to the vapour but it is not a linear function of the time (see Fig. 2 for typical results).

It is believed that free radicals at, or very near, the surface of the irradiated polymer act as centres for the polymerization of ^{14}C-acrylonitrile, and that polymer chains grow out from the surface of the irradiated material. If this is the case, the importance of the factors mentioned above can be understood. Work is in progress to elucidate the precise mechanisms of these reactions, and in particular to determine the number and average length of the branches grafted on the stock polymer.

The cobalt-60 source was installed by the Atomic Energy Research Establishment, Harwell. We thank the Department of Scientific and Industrial Research for a maintenance grant to one of us (D. E. E.) and Dr. H. W. Melville for his interest in this work.

J. C. Bevington
D. E. Eaves

Chemistry Department,
University,
Birmingham 15.
Sept. 11.

[1] Schneider, E. E., *Discuss. Farad. Soc.*, **19**, 158 (1955).
[2] Ballantine, D. S., Mesrobian, R. B., *et al.*, *J. Polymer Sci.*, **19**, 219 (1956).

Water Sealing of Detached Aluminium Oxide Anodic Film

The formation of boehmite on anodized and non-anodized aluminium surfaces by boiling-water treatment has been discussed by Hart[1]. He found by electron diffraction study of ammonium borate anodic films on aluminium that such treatment changed the quasi-amorphous structure of the coating to boehmite, whereas with films stripped from the metal this change did not occur. Hart suggested that the formation of boehmite was due to an electrochemical reaction in which aluminium ions from the aluminium base moved outward through the oxide film to meet hydroxyl ions and formed boehmite in the pores or on the outer surface. Application of this theory to sulphuric acid anodic coatings which are much thicker and more porous than the borate films is of

interest since it is generally believed[2] that the formation of boehmite during boiling-water sealing of such coatings is due to hydration of the aluminium oxide.

Aluminium sheet (99·87 per cent) of 0·5 mm. thickness was anodized (15 per cent wt. sulphuric acid, 21° C., 1·6 amp./sq. dm., 60 min.) to form an oxide film approximately 0·030 mm. thick. The weight gain on water sealing (de-ionized water, 100° C., *p*H 6·1, 30 min.) of such coatings was determined. The film weight was determined by dissolution of the coating, in a chromic – phosphoric acid solution[3]. Panels anodized in a similar manner were sheared into 1 cm. × 2 cm. squares and the unsealed oxide film was detached from these by a modified Wernick[4] technique (5–10 gm. mercuric chloride/100 ml. ethyl alcohol). The detached films were rinsed twice in absolute methyl alcohol. The weight gain on water sealing of detached oxide film was determined and compared with that of the non-detached film.

Electron diffraction patterns were obtained on non-detached and detached oxide films, in both the unsealed and water-sealed conditions. (Only results of examination of exterior film surface are discussed. Interior surfaces (metal side) give indefinite amorphous patterns.) A 50-kV. intensity beam was employed in an *EMU*-type *RCA* electron microscope. In examining the detached films it was necessary to evaporate a thin coating of aluminium on to both the non-examined side of the film and the diffraction sample holder. The treated film and holder were bonded together by use of Wood's metal to make a unit with increased heat capacity. This minimizes the heating of the oxide by the electron beam, which otherwise affects the structure as shown by a marked change in the observed pattern. (Heating of samples in this manner might be a useful technique in studying dehydration of various aluminas.)

The weight gain on sealing the film, which was sealed after being detached (7·1 per cent), was in good agreement with the value obtained for the non-detached film (7·7 per cent). No ring diffraction patterns were obtained with unsealed coatings, either detached or non-detached. Clear boehmite patterns were secured for sealed films (Fig. 1), including those sealed after removal from the aluminium. The patterns were compared with standard *ASTM* X-ray data and with results given by others[5,6]. A steam-sealed (115° C., 30 min.) stripped coating was examined and gave a slightly clearer boehmite ring pattern than did the water-sealed films.

The similarity of the results obtained with films detached from their aluminium base to those for non-detached films confirms that water sealing of sulphuric acid type anodic films is a hydration process and does not require the presence of metallic aluminium.

Roy C. Spooner

Aluminium Laboratories, Limited,
Kingston, Ontario.
Aug. 8.

[1] Hart, R. K., *Trans. Farad. Soc.*, **50**, 269 (1954).
[2] Wernick, S., and Pinner, R., "Finishing of Aluminium", 354 (Robert Draper, Ltd., 1956).
[3] *ASTM* Spec. *B* 137–45.
[4] Wernick, J., *J. Electrodep. Tech. Soc.*, **9**, 153 (1934).
[5] Harrington and Nelson, *Amer. Inst. Mech. Min. Eng.*, **7** (2), *TP* 1158 (1940).
[6] Russell, A. S., Alumina Properties, Tech. Paper No. 10 (Aluminium Research Laboratories, Pittsburgh, 1953).

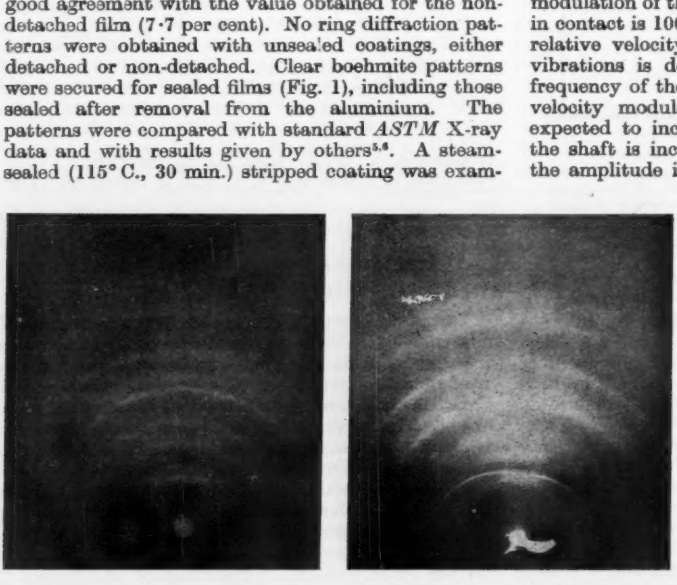


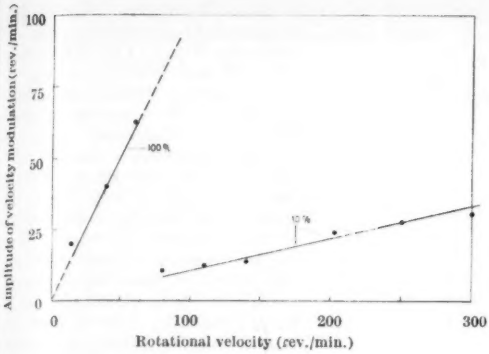
Fig. 1. Boehmite electron diffraction patterns of water-sealed sulphuric acid anodic films. Left, sealed on aluminium; right, sealed after removal from aluminium base

Torsional Vibrations of Rotating Shafts

A rotating shaft can exhibit torsional vibration when, because the dynamic coefficient of friction is less than the static value, the frictional force at the bearings supporting the shaft decreases as the shaft begins to rotate. The torque in the shaft when it begins to turn is greater than is required to overcome the running friction in the bearings, and the shaft accelerates and may overrun the drive until the speed of the shaft is reduced to zero. Then superposed on the steady rotation of the shaft there is a vibration of an amplitude such that the instantaneous angular velocity of the shaft varies between zero and rather more than twice the mean value. So-called 'stick-slip' vibrations of this type are well known—they may, for example, be responsible for brake squeal in automobiles.

With true 'stick-slip' vibrations the depth of modulation of the relative velocity of the two surfaces in contact is 100 per cent, and except when the mean relative velocity is very low, the frequency of the vibrations is determined primarily by the natural frequency of the system. Thus the amplitude of the velocity modulation of a vibrating shaft will be expected to increase linearly as the mean speed of the shaft is increased. In practice it is found that the amplitude increases in this way until a point is reached at which the vibrations suddenly cease. The transition does not occur at a fixed speed; but the chance of a system exhibiting 'stick-slip' vibrations decreases as the mean relative velocity of the surfaces in contact increases.

We have recently found, in experiments with a shaft of natural frequency about 25 c./s. and of diameter, at the bearings, of 0·625 in., that, on continuing to increase the speed of the shaft beyond the point at which 'stick-slip' vibrations ceased, the shaft vibrated at the same frequency but with an amplitude corresponding to a depth of modulation of only about 10 per cent. The behaviour of the shaft is shown in Fig. 1. In between the regions of



steady vibration with 100 or 10 per cent velocity modulation was a region of instability in which the shaft might run smoothly or might exhibit 'stick-slip' vibrations. The bearings were lubricated with a plain mineral oil, the conditions being such that a continuous oil film could not be maintained by hydrodynamic wedge action.

This small-amplitude vibration is believed to be associated with the time required for conditions in the bearings to come into equilibrium after a change in the velocity of the shaft.

H. Catling
A. E. De Barr

British Cotton Industry Research Association,
Shirley Institute,
Manchester 20.
Sept. 14.

Aluminium Molybdate and its Formation in Clay Minerals

The availability to plants of molybdate in some acidic soils may be increased by raising the *p*H. This behaviour of molybdate is analogous to that of phosphate, and suggests a study of its compounds with iron and aluminium, which are presumably responsible for holding molybdate in an insoluble form.

Unlike iron[1-3], aluminium has not been found as a naturally occurring molybdate. We have, however, prepared aluminium molybdates by precipitation from solutions of aluminium chloride and sodium molybdate. The precipitates have a Mo : Al ratio of 0·5, and have minimum solubility at *p*H 4·8. The temperatures of precipitation and digestion were varied, but no matter what these were over the range 20°–50° C. and 20°–90° C. respectively, the X-ray powder pattern and composition of the precipitates remained the same. The X-ray powder pattern consists of reflexions at 9·4 A. (weak), 4·78 A. (very strong), 3·25 A. (very weak), 2·44 A. (medium), 2·23 A. (strong), 1·99 A. (weak), 1·74 A. (strong), 1·46 A. (weak), and 1·35 A. (very weak). The material is highly hydrated and loses 34 per cent of its weight on heating to 800° C., and a further 17 per cent on heating to 1,000° C. The Mo : Al ratio suggests a basic salt; the formula $2(Al(H_2O)_4(OH)_2)MoO_4$ would agree with our analyses.

The aluminium minerals boehmite and halloysite are both found to adsorb large amounts of molybdate from solution over the *p*H range 4·0–5·5. At *p*H's above and below this range the amounts of adsorbed molybdate decrease sharply. These observations led us to examine the products obtained in the range of maximum adsorption. The minerals were therefore digested with sodium molybdate in aqueous suspensions at *p*H's 4·5–5·5 at 20° C. for 10 days, and soluble molybdate was then removed by washing. On examining the solid phases by X-ray diffraction it was found that two of the strongest reflexions in the powder pattern of aluminium molybdate (4·78 A. and 2·23 A.) had appeared in the boehmite and halloysite patterns. These reflexions cannot be attributed to any other material of which the X-ray powder pattern is known, and we may assume that molybdate has been chemisorbed and aluminium molybdate thus formed. This presumably is analogous to the formation of aluminium phosphates obtained on phosphating aluminium minerals[4]. Likewise it may be one way in which molybdenum is held in soils.

This work was done while one of us (A. A. M.) was holding a fellowship of the International Federation of University Women and working in the Department of Geology, University of Melbourne.

L. H. P. Jones

C.S.I.R.O., Division of
Plant Industry,
School of Agriculture,
University of Melbourne,
Victoria.

Angela A. Milne

C.S.I.R.O., Division of
Building Research,
Highett,
Victoria.

[1] Jones, L. H. P., and Milne, A. A., *Aust. J. Sci.*, **17**, 100 (1954).
[2] Simpson, E. S., *J. Roy. Soc. W. Aust.*, **12**, 57 (1926).
[3] Schaller, W. T., *Amer. J. Sci.*, **23**, 297 (1907).
[4] Haseman, J. F., Brown, E. H., and Whitt, C. D., *Soil Sci.*, **70**, 257 (1950).

A Randomly Interstratified Kaolin–Montmorillonite in Acid Clay Deposits in Japan

It has been accepted that, in general, the principal clay mineral in so-called bentonite and acid clay from Japan is montmorillonite. This fact is generally true, but closer examination has shown that these clays are, in general, very complex with regard to their mineral components. Recently, we have found certain clays closely associated with acid clay deposits and showing unusual properties; moreover, such clays are not so rare as we have hitherto anticipated. The purpose of this communication is to discuss the general mineralogical properties of such clays as illustrated by two representative reference specimens (Awazu and Nata clays from Ishikawa Prefecture) selected as samples which are as free from impurities as possible.

The X-ray powder reflexions of these clays consist of several broad reflexions near those of montmorillonite or hydrated halloysite (Fig. 1, 1, Awazu clay; 2, Nata clay), and a quartz reflexion (*Q*) is found associated with them. There is almost total absence of basal reflexions in the range 0°–20° (2θ) in spite of clear occurrences of principal prism reflex-

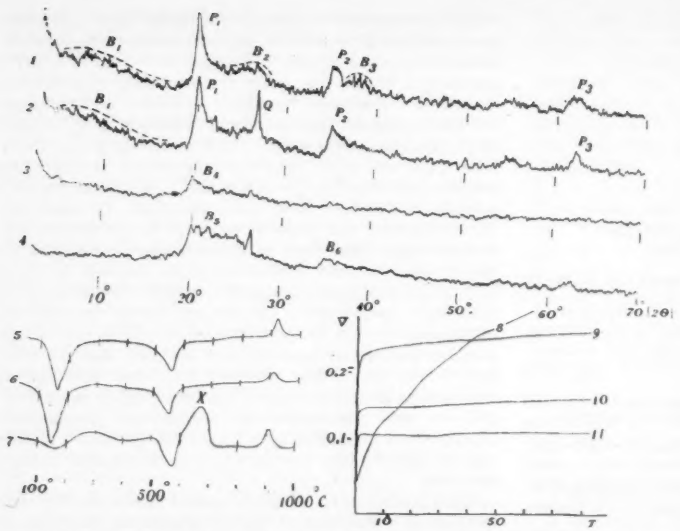


Fig. 1. Some properties of white clays associated with acid clay deposits in Japan. (1–4): X-ray diffractometer patterns. (5–7): differential thermal analysis curves. (8–11): the volume of absorbed water (V) in relation to time (T)

ions as P_1 (02,11), P_2 (13,20) and P_3 (06,33). The (06,33) reflexion occurs as a doublet (1·49 A. and 1·50 A.); the former spacing approximates to that of the kaolin minerals (1·486–1·497 A.) and the latter to montmorillonite (1·501–1·508 A.); these reference data have been obtained from Japanese specimens by us. On close examination, although basal reflexions are almost absent, it will be noticed that very broad bands (B_1) occur, spreading over the angle range of 5°–12° (2θ) (about 7–15 A.), including broad peaks having spacings of intermediate value between the two values above. Further, two broad bands are frequently noticed at about 3·5 A. (B_2) and 2·5 A. (B_3), which approximate to the (002) and (003) reflexions of a 7-A. kaolin mineral respectively. The effect of heat treatment at 600° C. and then air-quenching caused almost all powder reflexions to be weakened; only the (02,11) reflexion can be seen as a very broad band (Fig. 1, 3, B_4, Awazu clay). Treatment with ethylene glycol caused almost all reflexions to be weakened; even the (02,11) and (13,20) reflexions become very broad like a reflexion from a one-dimensional crystal (Fig. 1, 4, B_5, and B_6, Nata clay).

Differential thermal analysis curves (mean heating rate: 10 deg. per min.) are of the type of those of kaolin minerals (Fig. 1, 5, Awazu clay; 6, Nata clay). The thermal curves for the specimens treated by piperidine show the additional exothermic peak (X), indicating the presence of montmorillonite in the clays (Fig. 1, 7, Awazu clay). The chemical composition indicates an intermediate type between montmorillonite and a kaolin mineral; the data for Awazu clay are: SiO_2, 41·94; Al_2O_3, 30·12; Fe_2O_3, 2·42; FeO, 0·21; MgO, 1·52; CaO, 0·32; ignition loss, 11·10; H_2O (−) 12·88; TiO_2, 0·40 per cent; MnO, trace; total, 100·91 per cent. Electron micrographs indicate mainly plate-like crystals with somewhat irregular outlines, which mostly have elongated shapes. Crystals with pipe-like shapes are sporadically patchy. The change of the volume of absorbed water (V in c.c.) in relation to time (T in min.) (Fig. 1, 10, Awazu clay) is nearer to that of kaolinite (Fig. 1, 11) rather than those of montmorillonite (Fig. 1, 8, a specimen from Aterazawa, Yamagata; 9, a specimen from Ochiaizawa, Hanaoka).

These properties can be explained from our knowledge of clay mineralogy. Crystallites of these clays probably consist both of montmorillonite layers and kaolin mineral layers, and the proportion of these layers varies from portion to portion even in each crystallite. One hypothesis is that the core of each crystallite consists of montmorillonite (M) with kaolin mineral layers (K) becoming dominant, as one goes towards the edges, forming a randomly mixed layer mineral (Fig. 2). When such a crystallite is treated with ethylene glycol, swelling will occur selectively in the montmorillonite layers and it will give rise to small foldings in this crystallite, producing considerable disorder in the original crystal structure. *An alternative hypothesis is that* the core is largely occupied by a kaolin mineral, and on going toward its margin, montmorillonite layers become dominant. Such a scheme of interstratification leading to swelling of water-layers was proposed for the first time by MacEwan[1] for soil clay minerals. On the basis of the ideal chemical formulæ of kaolinite and montmorillonite, the proportion of these two kinds of minerals can be estimated from the chemical composition as about 80 per cent kaolinite and 20 per cent montmorillonite. It is very difficult to decide whether the kaolin mineral in question is kaolinite or hydrated halloysite as usually understood. X-ray diffraction data suggest that its crystallinity is lower; the 3·5 A. and 2·5 A. bands approximate to the (002) and (003) reflexions of a 7-A. kaolin mineral respectively; but pipe-like shapes are only noticed sporadically.

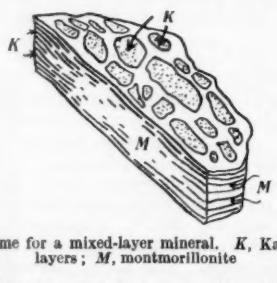


Fig. 2. Scheme for a mixed-layer mineral. K, Kaolin mineral layers; M, montmorillonite

We consider that such clays are alteration products representing an intermediate stage in the alteration of montmorillonite toward a kaolin mineral or vice versa.

Toshio Sudo
Hisato Hayashi

Geological and Mineralogical Institute,
Faculty of Science,
Tokyo University of Education,
Tokyo.

[1] MacEwan, D. M. C., *J. Soil Sci.*, **1**, 90 (1949).

Sensitivity to Ultra-violet Light of Infectious Tobacco Mosaic Virus Nucleic Acid

STRAINS of tobacco mosaic virus differ markedly in sensitivity to inactivation with ultra-violet light[1]. It is of interest to determine the basis for this difference in terms of the chemical structure of the virus strains. The discovery that the nucleic acid portion of the virus is by itself infectious[2,3] has enabled us to carry out experiments on the problem.

We have confirmed the observation that the nucleic acid fraction, prepared by the method of Fraenkel-Conrat and Williams[3], is infectious. We have also observed that an increased infectivity is obtained when the protein fragments are added to the nucleic acid preparation (reconstitution)[3,4]. Representative results are given in Table 1.

Table 1

	Conc. γ/ml.	Lesions on 30 half-leaves*
Untreated tobacco mosaic virus	0·10	2,400
Nucleic acid	60	1,355
Protein	50	0
Reconstituted tobacco mosaic virus:		*1,566*
Protein	25	
Nucleic acid	3	

* The assay consisted of a 5 × 5 Graeco-Latin square replicated three times.

Ultra-violet radiation survival curves were determined for the nucleic acid preparations from strains *U*1 and *U*2[5]; strains which differ 5½-fold in sensitivity to inactivation with ultra-violet light. Survival curves were also determined for preparations of reconstituted *U*1 strain. The preparations were irradiated at a concentration of 5×10^{-3} mgm./ml. in *M*/15, *p*H 6·9 phosphate buffer with a Westinghouse germicidal lamp, 782*L*-30, the output of which is primarily at 2537 A. Other techniques used for these experiments have been described[1]. The results are presented in Fig. 1. The nucleic acids from both strains *U*1 and *U*2 as well as the reconstituted *U*1 strain have the sensitivity of the *U*2 strain. It is of significance that the nucleic acids from the two strains do not differ in ultra-violet sensitivity; the difference in sensitivity of the strains thus cannot be attributed to differences which may exist in composition or structure of their nucleic acid fractions. Two preparations of reconstituted *U*1 strain had precisely the sensitivity of the nucleic acid, as indicated in Fig. 1. However, another preparation was intermediate in sensitivity between the nucleic acid and the untreated *U*1 strain. Fraenkel-Conrat and Williams[3] have indicated that the properties of reconstituted virus preparations may differ, depending upon the precise conditions of the experiment. Our data agree with theirs in indicating that preparations of reconstituted virus differ to varying degrees from the untreated virus. The fact that some of the reconstituted virus preparations have the same ultra-violet sensitivity as nucleic acid strongly suggests that the difference in ultra-violet sensitivity of the *U*1 and *U*2 strains cannot be attributed to a differential ultra-violet screening by their protein moieties.

The results presented here are most easily interpreted to signify that the difference in sensitivity of the two strains to inactivation with ultra-violet irradiation resides in the nature of the bonding between the nucleic acid and the protein moieties of the virus. The type of bonding existent in the *U*1 strain protects the virus from the full effect of the ultra-violet light, whereas the *U*2 strain is not so protected.

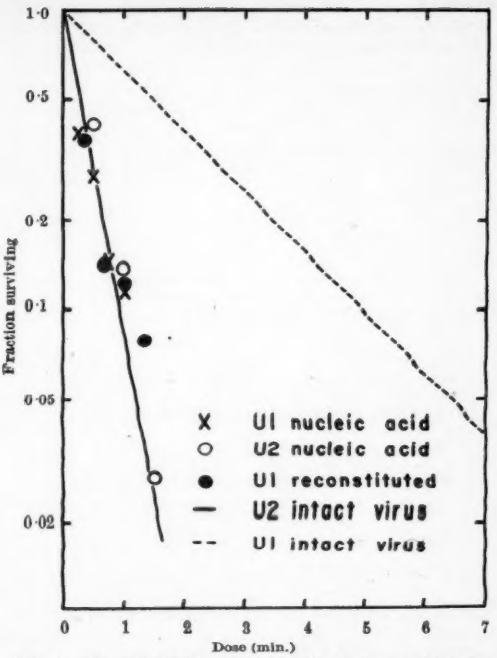


Fig. 1. The ultra-violet sensitivity of tobacco mosaic virus strains *U*1 and *U*2, the infectious nucleic acids derived therefrom, and one of the preparations of reconstituted *U*1 strain

Since little is known of the chemical alterations induced by ultra-violet light which lead to the inactivation of biological materials, it is difficult to speculate upon the possible bonding mechanisms which would lead to the type of protection observed in the *U*1 strain. Two possibilities are: (1) that energy absorbed by the nucleic acid can be transferred into the protein, where it may have little effect upon biological activity; (2) that the protein holds the nucleic acid in such a configuration that damage to the nucleic acid is easily repaired. We have made two observations which suggest that the bonding between nucleic acid and protein is different for strain *U*1 compared to strain *U*2. One of these observations is that the nucleic acid of the *U*2 strain is released more easily than that of the *U*1 strain by the heat-detergent method of Fraenkel-Conrat and Williams[3]; the other, that the *U*2 strain is considerably more sensitive to heat denaturation than is the *U*1 strain.

There are other biological materials which, although similar, differ in sensitivity of response to ultra-violet light. For example, a two-fold difference in sensitivity to inactivation of a bacterial virus is controlled by a single gene locus[6]. Another case is that of the inositol locus in *Neurospora* in which alleles have different ultra-violet induced reverse mutation-rates[7]. It is possible that in these cases, as in the one presented in this communication, the nature of the bonding between the genetic and non-genetic material affects the response of the genetic material to ultra-violet light.

We are indebted to Miss Carol Hoelle and Mr. Charles Ford for technical assistance. This work was

supported in part by a research grant, *RG*-4124, from the National Institutes of Health, U.S. Public Health Service, and contract *AT*(11–1)–34, Project 8 of the Division of Biology and Medicine, U.S. Atomic Energy Commission.

Albert Siegel
S. G. Wildman

Department of Botany,

William Ginoza

Atomic Energy Project,
University of California,
Los Angeles.
Aug. 14.

[1] Siegel, A., and Wildman, S. G., *Phytopath.*, **44**, 277 (1954).
[2] Gierer, A., and Schramm, G., *Nature*, **177**, 702 (1956).
[3] Fraenkel-Conrat, H., and Williams, R. C., *Proc. U.S. Nat. Acad. Sci.*, **41**, 690 (1955).
[4] Lippincott, J. A., and Commoner, B., *Biochim. Biophys. Acta*, **19**, 198 (1956).
[5] Siegel, A., and Wildman, S. G., *Virol.*, **2**, 69 (1956).
[6] Streisinger, G., *Virol.*, **2**, 1 (1956).
[7] Giles, N. H., Cold Spring Harbor Symp. Quant. Biol., **16**, 283 (1951).

Enzymic Oxidation of Glyceric Acid

The reduction of hydroxypyruvate to glycerate is brought about by crystalline L-lactic dehydrogenase of muscle[1] with the production of L-glyceric acid[2]. A substrate-specific D-glycerate dehydrogenase, which may or may not be accompanied by lactic dehydrogenase, occurs in extracts of higher plants[3]. Hydroxypyruvic acid phosphate is not able to replace pyruvic acid as a substrate for lactic dehydrogenase[3]. These enzymes require diphosphopyridine nucleotide, and their equilibrium, being far towards the reduced metabolite, is unfavourable for the study of the oxidative production of hydroxypyruvate. The importance of this substance as a substrate for transketolase[4] and transaminase[5] led us to study the action on glyceric acid of preparations containing lactic dehydrogenase from yeast, which is not so inhibited by pyruvate and requires no coenzyme[6–8].

An aqueous maceration extract of dried Delft baker's yeast was fractionated by precipitation with ammonium sulphate (final concentration 0·65 saturated), dialysis against versene (10^{-4} *M* disodium ethylenediamine tetraacetate) and removal of interfering impurities by precipitation at *p*H 5 and adsorption on small quantities of calcium phosphate gel. Lithium hydroxypyruvate, $CH_2OH.CO.COOLi + 1\ H_2O$, was crystallized analytically pure from water, the molecule of water being very firmly bound and possibly constitutive (crystalline salts of this acid have not previously been reported). Hydroxypyruvate (and glycolaldehyde) were assayed, in the presence of glycerate, by a new colour reaction with naphthoresorcinol in 23 *N* sulphuric acid at 100° for 20 min., the absorption of the resulting green solution being read at 660 mμ. The enzymic reduction-rates with methylene blue as hydrogen acceptor showed widely different *p*H optima for lactate (*p*H 5·5) and glycerate (*p*H 6·7). D-Glyceric acid was not attacked, and with DL-glycerate the extent of oxygen uptake and of hydroxypyruvate formation indicated the oxidation of one isomer (L-glycerate) only. The ratio of oxidation-rates at *p*H 6·7 for glycerate/lactate was ½, and the Michaelis constants at 37° were approximately $3{\cdot}5 \times 10^{-4}$ *M* (calculated) for L-lactate and $2{\cdot}5 \times 10^{-3}$ *M* for L-glycerate. DL-3-Phosphoglyceric acid was oxidized at about half the rate of DL-glycerate under these conditions, but some phosphate was split off; D-3-phosphoglycerate was not oxidized. Cytochrome *c*, like methylene blue, is reduced by glycerate in the presence of the enzyme preparation.

It is not yet clear if the same enzyme is responsible for the oxidation of lactate and glycerate in these experiments. The widely differing *p*H optima and the statement of Boeri *et al.*[7] that their highly purified yeast lactic dehydrogenase (cytochrome b_2) is unable to oxidize "any other α-hydroxy acid" would indicate different enzymes; on the other hand, no summation of reaction-rate occurs when lactate and glycerate are both present with our preparations. Further purification of the enzyme, now being undertaken, should decide this point.

Frank Dickens
D. H. Williamson

Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1. Sept. 1.

[1] Meister, A., *J. Biol. Chem.*, **197**, 309 (1952).
[2] Stafford, H. A., Magaldi, A., and Vennesland, B., *J. Biol. Chem.*, **207**, 621 (1954).
[3] Ballou, C. E., and Hesse, R. J., *J. Amer. Chem. Soc.*, **78**, 3718 (1956).
[4] de la Haba, G., Leder, I. G., and Racker, E., *J. Biol. Chem.*, **214**, 409 (1955).
[5] Sallach, H. J., in "Symposium on Amino-acid Metabolism, McCollum Pratt Institute", 782–87 (Johns Hopkins Press, 1954).
[6] Bach, S. J., Dixon, M., and Zerfas, L. G., *Biochem. J.*, **40**, 229 (1946).
[7] Boeri, E., Cutolo, E., Luzzati, M., and Tosi, L., *Arch. Biochem. Biophys.*, **56**, 487 (1955).
[8] Boeri, E., and Tosi, L., *Arch. Biochem. Biophys.*, **60**, 463 (1956).

An Apparent Anomaly in the Distribution of Radioiodinated Serum Albumin when added to Red Cell Suspensions

When 15 ml. of suitably diluted (1 in 500) serum albumin tagged with iodine-131 ('*RISA*', Abbott) is added to an equal volume of washed human red cells with a volume concentration ρ of about 0·4, and when the red cells are thrown down by centrifuging at 7×10^3 *g* for 15 min., the radioactivity of the supernatant fluid is invariably 10–15 per cent greater than that found in a blank system containing 15 ml. of '*RISA*' plus 15 $(1 - \rho)$ ml. of saline, even after a correction is made for the volume of the blank system being smaller than the volume of the system with which it is compared. If the red cells are first rendered spherical by the addition of 1·5 ml. of a distearyl lecithin sol (5 mgm./5 ml.), the supernatant fluid obtained by centrifuging is 20–25 per cent more radioactive than the supernatant fluid from an appropriately prepared blank.

This apparently anomalous result is explained by the examination, with phase optics, of the respective supernatant fluids. While the red cells are thrown down by the centrifuging, the supernatant fluids from the systems to which '*RISA*' has been added contain minute fragments and myelin forms which are not thrown down even at a centrifugal force of 2×10^4 *g*. These fragments and myelin forms apparently take up '*RISA*'. They are not found when only distearyl lecithin is added to the red cells; they appear, usually as tiny spherical fragments, when '*RISA*' is added to the red cells, and usually as much more numerous worm-like myelin forms when '*RISA*' is added to red cells rendered spherical with lecithin. Their association with '*RISA*' accounts for the relatively high radioactivity of the supernatant fluids containing them, and suggests that the effect of serum albumin in reversing the disk–sphere transformation produced by lecithin is related to the loss of myelin forms from the red cell surfaces.

By using a device which consists of a scintillation probe mounted against a 1-mm. slit in a mass of lead, and by moving the centrifuge tube (25 mm. in diameter) containing the supernatant fluid upwards and downwards, some indication has been found that there are more radioactive myelin forms in the upper than in the lower layers of the supernatant fluids.

The tiny fragments and myelin forms in the supernatant fluids can be demonstrated excellently with the interference microscope (AO-Baker). The refractive index of the myelin forms is about 1·48, which is about the same as that of lipids, and their water content must be small. The measurements, however, are difficult to make because of the smallness of the objects and because they are in active Brownian movement, so these results are given as approximations only.

This investigation was made under a grant, *H* 1598, from the U.S. Public Health Service.

ERIC PONDER
RUTH V. PONDER

Nassau Hospital,
Mineola,
New York.
July 31.

Effect of Thyroxine on the Swelling of Mitochondria Isolated from Various Tissues of the Rat

SEVERAL recent investigations[1–4] have suggested that an important function of thyroxine may be an 'uncoupling' of oxidative phosphorylation. However, studies with a multi-enzyme system (isolated from digitonin extracts of mitochondria[5]) capable of performing oxidative phosphorylation have indicated[6] that thyroxine and its analogues have no direct effect on this process. Concurrently[7], it has been observed that these compounds alter the morphology of rat liver mitochondria *in vitro*. In concentrations as low as 10^{-6} *M*, both thyroxine and triiodothyronine produce a prompt and marked swelling of the mitochondria. In contrast, 2,4-dinitrophenol, in concentrations which completely 'uncouple' oxidative phosphorylation, provides protection against swelling. It has therefore been postulated[6] that the uncoupling of oxidative phosphorylation produced by thyroxine in intact mitochondria is secondary to an alteration in the morphology of the mitochondria and not the result of a direct interaction of the hormone with the enzymes of oxidative phosphorylation.

Not all tissues respond in the same degree to the *in vivo* administration of thyroxine. Gordon and Heming[8] found that the oxygen consumption of slices of liver, kidney, diaphragm and heart from thyrotoxic rats was significantly greater than normal, while that of slices of spleen, brain and testis was not increased. Gross and Leblond[9] investigated the distribution of injected iodine-131 thyroxine in the rat and found that high concentrations occurred in plasma, liver and kidney and considerably smaller or negligible amounts in all other tissues tested. Likewise, we have found differences among the various tissues in the degree of mitochondrial swelling produced *in vitro* by thyroxine and its analogues.

Table 1 illustrates the markedly different susceptibilities of mitochondria from several organs. Mitochondria were isolated from the liver, kidney, heart, spleen and testis of adult male Wistar rats and the swelling assay conducted spectrophotometrically in a medium containing 0·3 *M* sucrose and 0·02 *M* *tris*-(hydroxymethyl)aminomethane at *p*H 7·4, as previously described[7]. Diaphragm mitochondria were isolated in a similar fashion following homogenization in a Waring blendor. Brain mitochondria were isolated by method I of Brody and Bain[10]. Each value in Table 1 represents the percentage decrease in optical density of a suspension containing the compound tested (3×10^{-5} *M*) less that observed in a control sample without the added compound. These values are taken as a measure of the swelling produced by the compound. The relative effects of thyroxine and triiodothyronine varied with different samples of these substances; one lot of thyroxine was more effective than triiodothyronine and one less so. Table 1 demonstrates that the swelling produced is striking with mitochondria from liver and kidney, while that with mitochondria from diaphragm and heart is much less marked. In accordance with failure of slices of spleen, brain and testis to show any change in oxygen consumption in thyrotoxic rats[8], essentially no swelling was produced by thyroxine or its analogues with the mitochondria from these tissues.

Table 1. DEGREE OF MITOCHONDRIAL SWELLING PRODUCED *in vitro* BY THYROXINE AND VARIOUS ANALOGUES

	L-thyroxine	D-thyroxine	L-triiodothyronine	D-triiodothyronine	Tetraiodothyroacetic acid	Triiodothyroacetic acid
Liver	30	33	47	41	25	17
Kidney	12	10	18	14	20	12
Diaphragm	5	4	7	7	5	5
Heart	2	2	9	5	9	9
Spleen	0	0	0	0	0	0
Brain	4	1	1	0	4	2
Testis	1	2	2	2	4	3

We wish to thank Dr. G. D. Greville for his interest, helpful suggestions and criticism.

D. F. TAPLEY*

Department of Biochemistry,
University of Cambridge.

C. COOPER

Department of Biochemistry,
School of Medicine,
Western Reserve University,
Cleveland, Ohio.
Aug. 6.

* Fellow of the Jane Coffin Childs Memorial Fund on leave of absence from the Department of Medicine, Columbia University, College of Physicians and Surgeons.

[1] Martius, C., and Hess, B., *Biochem. Z.*, **326**, 191 (1955).
[2] Hoch, F. L., and Lipmann, F., *Proc. U.S, Nat. Acad. Sci.*, **40**, 909 (1954).
[3] Maley, G. F., and Lardy, H. A., *J. Biol. Chem.*, **204**, 435 (1953).
[4] Klemperer, H. G., *Biochem. J.*, **60**, 122 (1955).
[5] Cooper, C., and Lehninger, A. L., *J. Biol. Chem.*, **219**, 489 (1956).
[6] Tapley, D. F., and Cooper, C., *J. Biol. Chem.*, **222**, 341 (1956).
[7] Tapley, D. F., *J. Biol. Chem.*, **222**, 325 (1956).
[8] Gordon, E. S., and Heming, A. E., *Endocrin.*, **34**, 353 (1944).
[9] Gross, J., and Leblond, C. P., *J. Biol. Chem.*, **184**, 489 (1950).
[10] Brody, T. M., and Bain, J. A., *J. Biol. Chem.*, **195**, 685 (1952).

Amœbicidal Action of Azaserine

IN 1954, a group of workers reported on a new tumour-inhibitory substance[1]. This substance, called azaserine, also possessed antibacterial activity against numerous microbial species[2]. Chemically, this substance is O-diazoacetyl-L-serine[3]. It has been reported that azaserine is a profound inhibitor of formate incorporation into the nucleic acids[4]. Since the role

of nucleic acid synthesis is particularly important in *Endamoeba histolytica*[5,6], the effect of azaserine on the amœbæ was studied.

The activity of azaserine was assayed in bacteria-free cultures of *E. histolytica* in a medium previously described[7]. Azaserine was amœbacidal in concentrations of 1/10,000 (100 μgm./ml.)–1/20,000 (50 μgm./ml.). Adenine (100 μgm./ml.), adenylic acid (100 μgm./ml.) and 2,6-diaminopurine (100 μgm./ml.) completely reversed the inhibitory effects of azaserine. Serine, methionine, 4-amino-5-imidazolecarboxamide and leucovorin (tested singly and in various combinations) effected only a partial reversal of the toxic action of azaserine. Guanine, guanosine and guanylic acid were completely inactive in reversing the action of azaserine.

It seems that azaserine functions as an antimetabolite in purine ring biosynthesis. Its mechanism of action against *E. histolytica* may be the prevention of 1-carbon incorporation as postulated[4,8] in the *de novo* synthesis of purines or the prevention of the closure of the acyclic purine ring precursor, thus blocking the synthesis of nucleic acids. Although 6-diazo-5-oxo-L-norleucine, another new tumour-inhibitory substance, was reported to inhibit the incorporation of formate into nucleic acids[8], no activity could be demonstrated against the amœbæ.

This work was supported (in part) by the Office of the Surgeon General, Department of the Army, Contract No. *DA*-49-007-*MD*-711. I am indebted to Dr. C. C. Stock for a gift of azaserine and 6-diazo-5-oxo-L-norleucine.

Mitsuru Nakamura

Department of Microbiology,
Boston University School of Medicine,
Boston, Mass.
Aug. 13.

[1] Stock, C. C., Reilly, H. C., Buckley, S. M., Clarke, D. A., and Rhoads, C. P., *Nature*, **173**, 71 (1954).
[2] Ehrlich, J., Anderson, L. E., Coffey, G. L., Hillegas, A. B., Knudsen, M. P., Koepsell, H. J., Kohberger, D. L., and Oyaas, J. E., *Nature*, **173**, 72 (1954).
[3] Bartz, Q. R., Elder, C. C., Frohardt, R. P., Fusari, S. A., Haskell, T. D., Johannessen, D. W., and Ryder, A., *Nature*, **173**, 72 (1954).
[4] Skipper, H. E., Bennett, jun., L. L., and Schabel, jun., F. M., *Fed. Proc.*, **13**, 298 (1954).
[5] Nakamura, M., and Baker, E. E., *Amer. J. Hyg.*, **64**, 12 (1956).
[6] Nakamura, M., and Jonsson, S., *Arch. Biochem. Biophys.* (in the press).
[7] Nakamura, M., *Proc. Soc. Exp. Biol. Med.*, **89**, 680 (1955).
[8] Maxwell, R. E., and Nickel, V. S., Abstracts of Papers, Amer. Chem. Soc., 129th meeting, Dallas, Texas, April 8–13, p. 15*M* (1956).

Riboflavin in Milk

Such studies as have been made on the riboflavin in milk point to the existence of species differences in respect of the forms in which this vitamin occurs in milk. Thus Kon and Mawson[1] reported that the concentration of riboflavin in human milk is very low, and found that the method of Emmerie[2], in which riboflavin is extracted by methanol was inapplicable to it. Davis *et al.*[3] found the methanol method unsuitable for sow's milk, and at the same time suggested that riboflavin might be present in sow's milk in a form different from that occurring in cow's milk. In view of the foregoing observations, the partition of riboflavin between free riboflavin, flavin mononucleotide and flavin adenine dinucleotide in the milk of several species has been studied.

Riboflavin was extracted from milk by the method of Bessey *et al.*[4]. From the neutralized extract the riboflavin was extracted with liquid phenol. Addition of ether threw out an aqueous phase containing all the riboflavin. Both by paper chromatography and by paper electrophoresis, free riboflavin, flavin mononucleotide and flavin adenine dinucleotide were separated. For the chromatographic separation a butanol/acetic acid/water system was used (Crammer[5]). For the paper electrophoresis a borate buffer (0·05 *M* borax, *p*H 9·2) was used, and a potential of 300 volts was applied for 5 hr. giving a current of 1·5 m.amp. per cm. width. Distinctly separated spots were made visible by ultra-violet illumination, and known samples of free riboflavin, flavin mononucleotide and flavin adenine dinucleotide were used for their identification. R_F values of the flavins for the solvent system used in the chromatography were 0·04 for flavin adenine dinucleotide, 0·13 for flavin mononucleotide and 0·35 for free riboflavin.

With the milk of cows, goats, ewes and rabbits two spots were observed, the larger one corresponding to free riboflavin and the smaller one to flavin adenine dinucleotide. On the other hand, with human, mare's and sow's milks usually only one spot was obtained, which corresponded to flavin adenine dinucleotide. Occasionally, however, with these last three types of milk, faint spots corresponding to flavin mononucleotide and free riboflavin were observed, but they probably resulted from slight hydrolysis of the flavin adenine dinucleotide. The authenticity of the flavin adenine dinucleotide was always established by enzymatic assay in the D-amino-acid oxidase system.

The ultrafiltrates from cow's and goat's milk were yellow, and under ultra-violet light they showed the characteristic greenish fluorescence of free riboflavin, whereas the ultrafiltrates of human and mare's milk were colourless. None of the ultrafiltrates contained flavin adenine dinucleotide, which suggests either that this molecule was too large to pass through the filter membrane or that it was present in the milks in a bound form.

Since in human, mare's and sow's milks the riboflavin is present as flavin adenine dinucleotide it might be thought that these milks, compared with cow's, goat's, ewe's and rabbit's milks, would contain greater amounts of enzymes, such as xanthine oxidase, that have flavin adenine dinucleotide as their prosthetic group. However, preliminary experiments have shown that xanthine oxidase is absent from human, mare's and sow's milks but is present in the milks of the other four species. This work is still in progress.

Our thanks are due to Dr. F. E. Hytten of the Midwifery Department, the University of Aberdeen, for sending us frozen samples of human milk, and the Veterinary Investigation Officers of the West of Scotland Agricultural College, for obtaining samples of sow's and ewe's milk.

V. V. Modi
E. C. Owen

Hannah Dairy Research Institute,
Kirkhill, Ayr.
Sept. 7.

[1] Kon, S. K., and Mawson, E. H., "Human Milk", Med. Res. Coun. Spec. Rep. No. 269 (H.M.S.O., London, 1950).
[2] Emmerie, A., *Z. Vitaminforsch.*, **7**, 244 (1938).
[3] Davis, V. E., MacVicar, R., Ross, C. B., Whitehair, C. K., Heiderbrecht, A. A., Braude, R., Coates, M. E., Henry, K. M., Kon, S. K., Thompson, S. Y., and Wilby, F., *Nature*, **165**, 522 (1950).
[4] Bessey, O. A., Lowry, O. H., and Love, R. H., *J. Biol. Chem.*, **180**, 755 (1949).
[5] Crammer, J. L., *Nature*, **161**, 349 (1948).

Nuclear Behaviour in Migrating Cells of the Rat's Corneal Epithelium

While conducting a series of experiments on the healing of needle pricks applied to the corneal epithelium of albino rats, perforating the epithelium only, it was seen that migration and proliferation of cells occur simultaneously, and before the commencement of mitosis. Multiple injuries were made. The eyes were then left to heal in the animal for varying periods after injury and, after removal, fixation and staining with hæmatoxylin, cross-sections were made and examined in series.

As is known, in these minute wounds migration of cells of the wound wall and around the wound commences roughly one and a half hours after application[1]. My investigations revealed an occasional split nucleus in a migrating cell one and a half hours after injury.

Two hours after application, and before any appreciable mitotic activity of the cells could be detected, there was considerable increase in the number of cells of the wound wall. This increase was manifested by an annular prominence of the epithelium of the wound wall, around the wound hole, made up of cells with clearly discernible membranes, of varying size, for the greater part smaller than average, although cells of average and more than average size were seen, too. Exceptionally, cells of a size much greater than that of ordinary epithelial cells were encountered.

Among the cells of average or more than average size, some with split nuclei or nuclei with furrows were often found. The occasional very large cells were always either bi- or tri-nucleate, or the nuclei displayed one or more furrows. Split nuclei were not limited to cells of the basal layer. Although infrequently, abnormal mitoses were sometimes seen. These could not be detected one and a half hours after injury.

Three hours after injury, a fair number of abnormal mitoses were observed in the annular prominence. Occasionally, these occurred in layers other than the basal. Many approached the appearance of normal figures more than did those two hours after injury. Cells with split nuclei persisted.

At times a normal mitotic figure was found in the normal epithelium between the wounds.

Four hours after application of the injury many normal mitoses were seen in the epithelium between the wounds. In the annular prominence cells with split nuclei and abnormal mitoses persisted.

That there is strong inhibition of mitosis following such injuries of the corneal epithelium in rats was found by Friedenwald and Buschke[1]. They state that *in vivo* a return to normal count is found around the fourth hour and some overshooting occurs between four and six hours after injury.

From the above it was concluded that, as in this instance there is cell proliferation without any normal mitotic figures present, cell multiplication has occurred by a process other than mitosis. Consequently, injury as such causes a change in the mode of cell division in the immediate vicinity of a wound.

Further, from a detailed study of the mechanism of wounding[2] which showed that, at least in a certain area, the only injury to the migrating cells is through compression, it was concluded that, of itself, compression of the epithelium produces a change in the mode of cell division.

This work received financial support from the Council for Scientific and Industrial Research, South Africa.

Johanna C. Heerema
Zoology Department,
University of Cape Town.
Sept. 7.

[1] Friedenwald, J. S., and Buschke, W., *J. Cell. and Comp. Phys.*, 23, 95 (1944).
[2] Heerema, J. (to be published).

Influence of Atropine and Morphine on the Liberation of Acetylcholine from the Guinea Pig's Intestine

It has been shown by Chujyo[1] that distension of the lumen of the guinea pig's intestine results in ar increased output of acetylcholine. Distension of the lumen also leads to a contraction of the longitudinal muscle, which is probably brought about by the acetylcholine released. Atropine and morphine abolish this contraction; but the mechanism of the action of these two drugs appears to be different. The following experiments show that whereas atropine apparently acts by preventing the action of the released acetylcholine on the longitudinal muscle, morphine inhibits the release of acetylcholine.

Distended strips of the guinea pig's small intestine were incubated in Tyrode solution aerated with 95 per cent oxygen + 5 per cent carbon dioxide at 38° C. in the presence of 10 μgm./ml. eserine. Four samples were obtained from the intestine of one animal; two were incubated in the presence of atropine or morphine, the other two served as controls. After 1 hr. incubation the Tyrode solution was removed, cooled, made isotonic to frog saline and assayed for acetylcholine on the eserinized frog rectus muscle. 1 gm. of intestinal tissue released between 2 and 6 μgm. acetylcholine per hr. The same release, or an insignificant increase in the release, was obtained when the experiment was carried out in the presence of 5 μgm./ml. atropine in the bath fluid. On the other hand, the presence of 10 μgm./ml. morphine in the Tyrode solution reduced the output of acetylcholine by 40–60 per cent although morphine is 3–5 times less effective in paralysing the guinea pig's ileum than atropine[2]. These results are given in Table 1; each figure represents the mean of two samples.

The present observation agrees with the corresponding one of Paton[3], who found that the output of acetylcholine from the intestine on co-axial electrical stimulation of the guinea pig's ileum was depressed by morphine.

The effect of morphine in preventing the release of acetylcholine brought about by distension or stimulation of the gut is best explained on the assumption that the acetylcholine is released from nerve fibres or nerve endings which are inhibited by

Table 1

	Liberation of acetylcholine* (μgm./gm./hr.)				
Exp. No.	Control	Atropine (5 μgm./ml.)	Exp. No.	Control	Morphine (10 μgm./ml.)
1	2·55	2·30	5	2·25	1·35
2	2·75	3·20	6	3·00	1·35
3	5·95	6·50	7	5·30	2·25
4	4·90	5·10	8	5·00	2·15
			9	4·10	1·60

* Expressed in terms of acetylcholine chloride.

morphine. The nature of these nervous structures, however, is uncertain. Ganglion cells can be excluded according to the results of Feldberg and Lin[4] and also because morphine does not inhibit ganglion cells in the intestine[2]. On the other hand, morphine was found to abolish contractions of the guinea pig's duodenum on stimulation of the vagi, probably by an action on postganglionic structures[5].

W. Schaumann
Pharmakologisches Institut der Universität,
Frankfurt am Main. Sept. 4.

[1] Chujyo, N., *Amer. J. Physiol.*, **174**, 196 (1953).
[2] Schaumann, W., *Brit. J. Pharmacol.*, **10**, 456 (1955).
[3] Paton, W. D. M., 20th International Physiol. Congress, Brussels, Abstr. of Comm., 708.
[4] Feldberg, W., and Lin, R. C. Y., *J. Physiol.*, **111**, 96 (1950).
[5] Schaumann, W., *Arch. Exp. Path. u. Pharmakol.*, [**229**, 432 (1956)].

Incorporation of Methionine (Sulphur-35) into the Central Nervous System

Twenty-four hours after administration, methionine (sulphur-35) in the central nervous system is largely found in protein molecules[1,2]. In other words, incorporation of methionine (sulphur-35) is a good indicator of proteosynthetic activity of different parts and structures of the central nervous system.

A number of authors have studied the incorporation of methionine (sulphur-35) into the central nervous system[3–7]. In agreement with their work, it has been demonstrated that a relatively larger amount of methionine (sulphur-35) is incorporated into the grey matter of brain and spinal cord than into the white matter.

Experiments were carried out on eight male police dogs aged two years and adequately fed. Methionine (sulphur-35) was administered intraperitoneally (200 microcurie – 1 millicurie). Twenty-four hours later the animals were killed. The coated method was used for histoautoradiography with an emulsion developed in our laboratory[8].

Activity of sulphur-35 determined in mineralized tissues[1] decreases in the following order: cerebellum, brain cortex, pons, spinal cord, peripheral nerve.

Autoradiography of coronal sections of the brain showed that methionine (sulphur-35) accumulates to a larger extent in the grey matter (Fig. 1). No obvious differences between the activity of the grey matter of the cerebral cortex and of basal ganglia could be demonstrated. The isotope does not accumulate extensively in the areas surrounding the ventricles.

Fig. 1. Coronal section through the brain of the dog, showing greater incorporation of methionine sulphur-35 in the grey matter of the cortex

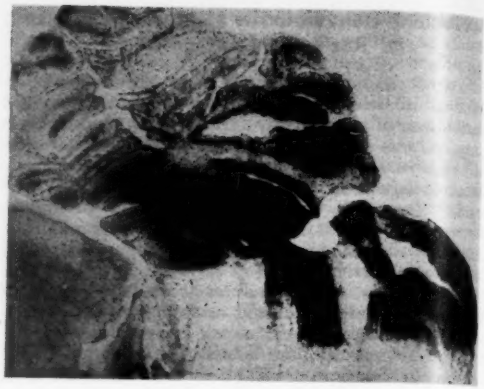


Fig. 2. Incorporation of methionine sulphur-35 into the cerebellum. Higher concentrations are present in phylogenetically older regions of the cerebellum. Unstained. (× 15)

The following areas were historadiographed: gyrus sylvius ant. and post., g. sigmoideus post., g. enterolateralis (occipital pole), basal ganglia, palleo- and neo-cerebellum, pons, spinal cord. In certain cellular structures of the cerebral cortex accumulation of methionine sulphur-35 could not be demonstrated. The same holds good for the grey matter of the pons and basal ganglia. The border-line between grey and white matter is relatively sharp, activity in the white matter being up to twice as low as in the grey matter. In the cerebellum activity

Fig. 3. Concentration of methionine sulphur-35 in motor cell from anterior spinal horn. Coated radioautograph. Hæmatoxylin-eosin. (× 975)

is highest in the medial parts (phylogenetically old cerebellar areas; Fig. 2). Under higher magnification it is possible to demonstrate greater accumulation of methionine sulphur-35 in the granular layer of the cerebellar cortex.

Methionine sulphur-35 is not distributed equally throughout the grey matter of the spinal cord. The largest amount is present in motor cells of the anterior horn (Fig. 3). Even in the anterior horns it is possible to differentiate cells with activity higher than the rest.

Very little methionine sulphur-35 is present in the cerebrospinal membranes. No accumulation of methionine sulphur-35 could be demonstrated in the central nervous system surrounding blood vessels or in the vascular walls themselves.

J. Fischer
J. Koloušek*
Z. Lodin*

Laboratory of Neuropathology,
Institute of Pathological Anatomy
of the Medical Faculty,
and Institute of Physiology of the
Czechoslovak Academy of Sciences,
Prague. Aug. 8.

* Present address: Czechoslovak Academy of Sciences, Institute of Physiology, Praha XIX, Na cvičišti 2, Czechoslovakia.

[1] Galtonde, M. K., and Richter, D., *Biochem. J.*, **59**, 690 (1955).
[2] Koloušek, J., and Lodin, Z. (in the press).
[3] Greenberg, D. M., and Winnick, T., *J. Biol. Chem.*, **173**, 199 (1948).
[4] Tarver, H., and Morse, L. M., *J. Biol. Chem.*, **173**, 53 (1948).
[5] Cohn, P., Galtonde, M. K., and Richter, D., *J. Physiol.*, **126**, 7P (1954).
[6] Palladin, A. V., and Vladimirov, D. E., "Primeneniye izotopov v technike biologii i selskom chozyaystve", 227 (Izdat. Akad. Nauk, S.S.S.R., Moscow, 1955).
[7] Lodin, Z., and Koloušek, J., *Physiol. Bohemoslovenica*, Supp., **5**, 43 (1956).
[8] Fischer, J., Koloušek, J., and Lodin, Z., "Československá Morfologie" (in the press).

Possible Interaction of Anti-diuretic and Sodium-retaining Hormones in the Kidney

While investigating the renal excretion of water and sodium by rats in response to intravenous infusion of isotonic saline[1,2], it became desirable to consider some aspects of the renal tubular re-absorption of these substances[3]. We have attempted to do this by considering a model of the tubules based upon properties of a membrane the characteristics of which have already been studied. Some properties of frog skin have been described by Ussing and Zerahn[4], and it seems that this membrane can act as a 'sodium pump', actively transferring sodium ions; the activity of the 'sodium pump' appearing as an e.m.f. of about 100 mV. across the membrane. The rate of water transfer may be regarded as dependent upon hydrostatic and osmotic pressure differences across the membrane and upon its permeability to water.

For a membrane having these properties the rate of sodium transfer may be shown to be a function of the rate of transfer of water and vice versa. In this case a change in the flux of water across the membrane may lead to a similarly directed change of the sodium flux. Were the e.m.f. developed by the 'sodium pump' controlled by a sodium-retaining hormone and the permeability of the membrane to water by an antidiuretic hormone[5], then there would appear to be an interaction between these two hormones which is, however, a function of the membrane upon which they act.

It is suggested that the activity of the renal tubules in re-absorbing sodium and water from the lumina may show properties not entirely dissimilar from the characteristics of frog skin mentioned above. On this supposition the renal responses to certain physiological stimuli have been deduced and found to agree with observations. In particular, the excretion of a urine initially hypotonic in response to an isotonic saline infusion is explained, as also is the inability of physiological doses of antidiuretic hormone to inhibit diuresis caused by infusing isotonic or hypertonic saline.

D. F. Cole
(I.C.I. Fellow)

Department of Medicine,

J. F. Meredith

Department of Electrical Engineering,
University of Durham,
Newcastle upon Tyne 1.
Sept. 14.

[1] Cole, D. F., *Acta Endocrin.*, **19**, 397 (1955).
[2] Cole, D. F., *Quart. J. Exp. Physiol.* (in the press).
[3] Cole, D. F., and Meredith, J. F., *Bull. Math. Biophys.* (in the press).
[4] Ussing, H. H., and Zerahn, K., *Acta Physiol. Scand.*, **23**, 110 (1951).
[5] Sawyer, W. H., "The Hormonal Control of Water and Salt Electrolyte Metabolism in Vertebrates", Mem. Soc. Endocrinol., No. 5, Pt. 2, Ed. I. Chester Jones and P. Eckstein, pp. 49 and 69 (Cambridge University Press, 1956).

Effect of Fast Neutrons on Different Stages of Spermiogenesis in *Drosophila melanogaster*

From X-ray studies, it is known that the rates of chromosome aberrations vary with the age of the males[1] and the time from irradiation to insemination[2]. Lüning[3] showed that these variations were due to differences in the rates of chromosome breaks in different stages of spermiogenesis and that in spermatids there was a higher rate than in mature spermatozoa. After Baker and Von Halle's[4] observation that there was a difference in the rate of dominant lethals in sperm between the first and second day, this was further studied by Lüning[5] on other types of aberrations. He proposed that this difference was due to a difference in the rate of breaks in 'mature' (the first-day) and 'near mature' (the second-day) sperm. This conclusion ought, however, to be revised as some yet unpublished experiments have shown.

From experiments by Baker and Von Halle[6] with fast neutrons it is known that the rates of dominant lethals were the same in sperm from the first and the second day. This result is difficult to explain on the hypothesis of a difference in sensitivity between sperm of the first two days.

Hence it seemed to us worth while to attack the problem of different sensitivity by means of irradiation with fast neutrons also on other types of aberrations. In this study we used two types of mutations, namely, sex-linked recessive lethals, and II–III translocations. The purpose of this experiment was also to obtain information concerning the effectiveness of the fast neutrons compared with X-rays on the two types of mutations. In order to be sure that the dose and stages in spermiogenesis were the same for both types of mutations, certain precautions have to be taken. In our case we used a 'dual-purpose' stock from which we could take the daughters for tests of recessive lethals and their brothers for translocation tests.

Table 1

Day of mating after irradiation	Recessive lethals X-chr. tested	Lethals *Abs n : r*	Per cent
1	918	10	1·09
2	953	9	0·94
5–6	1,137	24	2·11
Day of mating after irradiation	**II–III translocations II–III chr. tested**	**Translocations *Abs n : r***	**Per cent**
1	1,042	32	3·07
2	1,021	35	3·43
5–6	794	61	7·68

The males were taken from *sp ; th* stock, the females from an sc^{S1} *B InS* w^a sc^8 ; *cn bw* ; e^{11} stock. The *X*-chromosome in this is the so-called Muller-5 = *M*5. The males were irradiated in the Swedish uranium reactor when 1–24 hr. old. They were afterwards mated to virgin females and then transferred to new virgin females at the following times after irradiation, 24, 48 and 96 hr. They were discarded 144 hr. after the treatment. Eggs were collected from females mated during the first, second and fifth–sixth day after treatment. The F_1 daughters were mated singly to *M*5 males in vials and the F_2 offspring was then examined for the occurrence of recessive lethals. The F_1 males were mated singly to *cn bw* ; e^{11} females and their offspring was analysed for II–III translocations. The results are presented in Table 1.

A comparison between the first and the second broods shows no differences for both types of aberrations, which is in agreement with Baker and Von Halle's results. The comparison between these first two days on one hand and the fifth–sixth day on the other shows for both types of mutation about twice as high a frequency in the latter as in the former.

These results confirm Baker and Von Halle's observations on dominant lethals, as the same rates of recessive lethals and translocations respectively are induced in the first as in the second brood. Hence one might conclude that the same rates of breaks are induced in the sperm of the two batches. In sperm supposed to have been irradiated in the spermatid stage a significantly higher rate of aberrations of both kinds was induced. This is in agreement with the results after X-ray irradiation and is consistent with the hypothesis of a differential sensitivity of various stages in spermiogenesis. It is, however, not possible to determine whether the degree of sensitivity is the same for X-rays and fast neutrons.

From the experiments presented above we may conclude that fast neutrons induce about the same rate of chromosome breaks in sperm to be inseminated during the first two days but a significantly higher rate in sperm to be ready during the fifth–sixth day mating period.

K. G. Lüning
Sten Jonsson

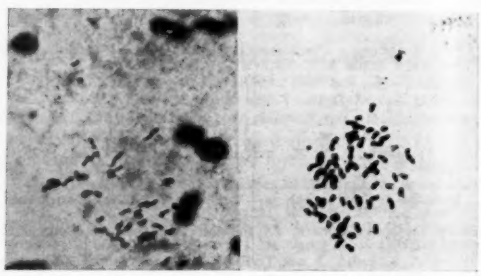
Institute of Genetics,
University of Stockholm,
Stockholm.
Sept. 11.

[1] Strömnaes, Ö., *Genetics*, **34**, 462 (1949).
[2] Bonnier, G., and Lüning, K. G., *Hereditas*, **36**, 445 (1950).
[3] Lüning, K. G., *Hereditas*, **38**, 321 (1952).
[4] Baker and Von Halle, *Proc. U.S. Nat. Acad. Sci.*, **39**, 152 (1953).
[5] Lüning, K. G., *Hereditas*, **40**, 295 (1954).
[6] Baker and Von Halle, *Science*, **119**, 46 (1954).

Production of Heteroploidy in the Three-Spined Stickleback, *Gasterosteus aculeatus* (L.)

Many data exist on natural and induced polyploidy in Amphibia[1,2] ; but knowledge on the subject still remains scanty in other groups of vertebrates. Spontaneous and experimentally produced polyploidy has been studied in mouse embryos[3-7]. Among fishes, production of triploidy by cold treatment has been reported up to cleavage stages[4]. The present work has been undertaken to induce triploidy by heat and cold treatment of the eggs of the three-spined stickleback and to keep alive the triploids thus produced.

The diploid number of chromosomes of *Gasterosteus aculeatus* as studied from squash preparations of testes, entire embryos and conjunctiva of the eyes of adult fishes is 42 ± 2. The small size of the chromosomes still leaves some doubt whether the observed variation in the counts is due to technical limitations or to an actual variation in the chromosome number of different individuals.



a *b*

Fig. 1. Squash preparation of the conjunctiva of (*a*) diploid, and (*b*) triploid juvenile fish showing 42–44 and 63–66 chromosomes respectively. (× 1,000)

For the production of triploidy, the eggs, just after insemination, were subjected to heat or cold treatment which probably suppressed the formation of the second polar body and resulted in the fusion of two maternal and one paternal sets of chromosomes. The best temperature for heat treatment was between 32·5° and 34° C. provided the eggs were treated for 5 min. within 15 min. after insemination. However, heat shock always resulted in a high rate of mortality and the production of many abnormalities in the surviving embryos. Therefore cold treatment, which yielded better results, was preferred. It was soon noted that the fertilized eggs can bear a temperature of 0° C. up to 3 hr. ; those treated for 5, 6 and 15 hr. died at cleavage stages. In order to find the best time at which to begin the treatment, the eggs were exposed to the cold treatment for 3 hr., beginning at 3, 5, 10 and 15 min. after insemination. The results obtained are shown in Table 1.

Experiments for triploidy are successful only if the eggs are treated with cold within 5 min. after insemination, 3 min. being the best time. A cold treatment of 3 hr. still causes a very high mortality. The shortest treatment which produces triploidy without causing too high a mortality was found to be 1½ hr. (see Table 2), and hence all later experiments were confined to this treatment.

The construction of a simple apparatus which produced a continuous current of water made easy the

Table 1. RESULTS OBTAINED BY SUBJECTING THE EGGS TO 0° C. FOR 3 HR.

Time of treatment after insemination	Total eggs treated	Survival up to lens formation	Analysable	Haploid	Diploid	Triploid	Mosaic
3 min.	514	42	27	0	1	18	8
5 ,,	465	131	86	0	49	22	15
10 ,,	226	7	7	0	0	0	7
15 ,,	85	45	38	17	14	1	6

Table 2. RESULTS OBTAINED BY SUBJECTING THE EGGS TO 0° C. FOR VARYING PERIODS, ALL BEGINNING 3 MIN. AFTER INSEMINATION

Duration of treatment	Total eggs treated	Survival up to lens formation	Analysable	Haploid	Diploid	Triploid	Mosaic
½ hr.	101	42	40	7	24	0	9
1 ,,	111	36	30	2	18	1	9
1½ ,,	132	40	31	2	3	18	8
2 ,,	55	25	19	1	3	7	8
2½ ,,	96	11	11	0	2	6	3
3 ,,	514	42	27	0	1	18	8

rearing of embryos up to yolk absorption. The young diploid and triploid fish kept in the aquaria have by now reached two-third adult size.

All chromosome counts on embryos were made on squash preparations of whole embryos shortly after lens formation; those of later stages were carried out on squash preparations of the conjunctiva of one eye without killing the fish since the wound heals within a short time.

This work was done under the supervision of Dr. M. Fischberg, to whom I am grateful for his constant help and encouragement.

H. SWARUP

Dept. of Zoology and Comparative Anatomy,
University Museum,
Oxford.
Sept. 5.

[1] Fankhauser, G., *Quart. Rev. Biol.*, **20**, 20 (1945).
[2] Fischberg, M., *Genetics*, **24**, 213 (1948).
[3] Beatty, R. A., and Fischberg, M., *Nature*, **163**, 807 (1949).
[4] Fischberg, M., and Beatty, R. A., *J. Exp. Biol.*, **118**, No. 2, 321 (1951).
[5] Fischberg, M., and Beatty, R. A., *J. Genet.*, **50**, No. 3, 455 (1952).
[6] Fischberg, M., and Beatty, R. A., *Evolution*, **6**, No. 3, 316 (1952).
[7] Edwards, R. G., *Nature*, **174**, 276 (1954).
[8] Swardson, G., Medd. St. Undersoken.-o. Forsoksanst f. Sotvattersfisket, No. 23 (1945).

Further Observations on the Blood Factor Di[a]

IN a previous communication[1] we remarked that the blood factor Di[a] promised to be of great anthropological interest: it might prove to be a Mongoloid characteristic. Since then we have, on one hand, found it in a second northern Indian tribe—the Crees of northern Manitoba—three Di(a+) out of thirty-five, and on the other hand in none of thirty-five American Negroes, while Dr. Layrisse tells us that he has tested a number of Nigerians without finding any positive. It looked, indeed, as if Di[a] were a Mongoloid 'marker', so it came as a surprise when we found no Di(a+) among 156 Eskimos.

Both the Cree Indians and the Eskimos were patients in tuberculosis sanatoria. Since the frequency of the factor in these Crees was essentially the same as in the neighbouring healthy Chippewa it would not seem that there could be any relationship between the facts that the Eskimos had tuberculosis and that they were all Di(a−). The use of sanatorium populations has the advantage that the patients come from many small populations scattered over a wide area and in this sense represent a random sample of the general population of that area. Laughlin[2] has pointed out the variations that occur in the blood-group gene frequencies in smaller and larger isolates among the Eskimo. We think the sanatorium method of sampling should give a true overall picture. The Eskimos tested were all from the eastern Canadian arctic, which includes Hudson Bay, Baffinland and Labrador. We hope to extend these studies to the western arctic.

MARION LEWIS
BRUCE CHOWN
HIROKO KAITA

Blood Group Reference and Research Laboratory,
735 Notre Dame Avenue,
Winnipeg.
Sept. 13.

[1] Lewis, M., Ayukawa, H., Chown, B., and Levine, P., *Nature*, **177**, 1084 (1956).
[2] Laughlin, W. S., Symposia on Quantitative Biology, **15**, 165 (1950).

Bacteriological Studies of 'Infected' and 'Uninfected' Chicks in Relation to Antibiotic Growth Stimulation

COATES *et al.*[1] described an infective growth-depressing condition in premises where chicks had been reared for some time. The condition was counteracted by penicillin in the diet, and was not present in clean premises where chicks had not previously been kept. Work on the relationship between *Clostridia* and antibiotic growth stimulation has been critically reviewed by Jukes[2].

In our investigation of the so-called infection, the gut flora of chicks from clean and infected premises was examined during the first few days of life; a gut flora similar to that of adult birds was found in chicks two days after they began to feed[3]. Spores of *Clostridium welchii* type *A* were found in the cæca of chicks from the infected premises one day after feeding, but not in those from the clean environment. Total counts made in series with spore counts showed that *Clostridia* are one of the most numerous components of the developing gut flora of the chick.

In further experiments the infected premises were thoroughly cleaned and redecorated, and the first batch of chicks placed therein was examined. *Cl. welchii* was not found in these birds, but was present in the cæca of chicks from the original clean premises. The chicks from the original clean quarters were infected, that is, their weights were depressed, in comparison with the weights of chicks from the redecorated premises. Subsequent batches of chicks placed in the redecorated premises showed growth depression compared with penicillin-fed controls, and also *Cl. welchii* in their cæca. Thus the presence of *Cl. welchii* in the cæca of chicks one day after feeding indicated 'infection'.

Fig. 1. Differences in lecithinase production on neomycin egg-yolk agar between *Cl. welchii* from 'infected' (top) and penicillin-fed (bottom) chicks

Further experiments were made with birds from infected premises with and without penicillin in the diet, *Cl. welchii* being enumerated by the method of Lowbury and Lilly[4]. In the first experiment of this series, *Cl. welchii* was not found in either group one day after feeding; however, it appeared on the second day in the control group, but not in the group fed penicillin. *Cl. welchii* was not found in the penicillin-fed group in three subsequent experiments on either the first or second day. In another experiment chicks from an alternative source were used, and *Cl. welchii* occurred in both penicillin-fed and control groups in equal numbers. However, Fig. 1 shows that, in contrast with the activity of *Cl. welchii* strains from the control group, lecithinase (α-toxin) production on neomycin egg-yolk agar was markedly less in strains from the penicillin group (lower plate); the dark areas show lecithinase activity. Strains of *Cl. welchii* from this group produced as much lecithinase when subcultured in the absence of penicillin as strains isolated from the control group.

The presence of *Cl. welchii* in the gut of chicks thus appears to be related to the growth-depressing condition. There are distinct differences in the presence and activity of *Cl. welchii* in the first few days of life between chicks from clean and infected premises, and between infected and penicillin-fed chicks. Moreover, the metabolism of at least one component (*Cl. welchii*) of the flora of infected chicks can be altered by penicillin in the diet, the effect for the host being equivalent to elimination of the organism. The experimental details of this work will be published elsewhere.

M. Lev
C. A. E. Briggs
Bacteriology Department,
Marie E. Coates
Nutrition Department,
National Institute for Research in Dairying,
University of Reading.
July 24.

[1] Coates, M. E., Dickinson, C. D., Harrison, G. F., Kon, S. K., Porter, J. W. G., Cummins, S. H., and Cuthbertson, W. F. J., *J. Agric. Sci.*, 3, 43 (1952).
[2] Jukes, T. H., "Antibiotics in Nutrition", 29 (Medical Encyclopedia, Inc., New York, 1955).
[3] Lev, M., and Briggs, C. A. E., *J. App. Bact.* (in the press).
[4] Lowbury, E. J. L., and Lilly, H. A., *J. Path. and Bact.*, **70**, 105 (1955).

Linkage Group XIV of the House Mouse

Preliminary linkage tests with the house mouse mutant 'crinkled'[1] showed a deficiency of recombinations between crinkled and flexed-tail[2] in repulsion inter-cross matings. Owing to a serious shortage of flexed-tail segregants, back-cross matings in coupling and repulsion were set up to estimate the percentage recombination between these loci. Because of the lack of vigour of crinkled flexed-tail homozygotes, these could only be used as male parents. Consequently, the recombination observed refers to that of doubly heterozygous females. Flexed-tail was classified within 24 hr. of birth by the transient anæmia visible at that age, and crinkled at 1–2 weeks of age by the appearance of the coat and tail. The number of offspring from the back-cross matings are given in Table 1.

Table 1

Phase	Normal	Flexed and crinkled	Flexed	Crinkled	Total
Coupling	49	32	17	23	121
Repulsion	54	29	65	95	243

There is a shortage of flexed-tail animals which may, in part, be due to pre-natal losses, but is certainly mainly due to losses after birth and before the classification for crinkled. There is no evidence to suggest that with classification of flexed-tail by the anæmia visible at birth, the deficiency may be due to normal overlapping (see also Grüneberg[3]). To allow for reduction in viability, the data for coupling and repulsion phases were combined by Fisher's method[4]. The estimated recombination percentage between crinkled and flexed-tail is $33{\cdot}6 \pm 2{\cdot}6$ per cent.

Linkage tests of crinkled were made with marker genes in all the known linkage groups except IV, for which no suitable marker was available. The results are summarized in Table 2, which shows the estimated recombination percentages and their standard errors obtained by the procedure of Carter and Falconer[5].

The values obtained show no significant deviation from independent assortment of crinkled with any other marker. In addition, published data[6] provide no evidence that the flexed-tail locus is linked to

Table 2. INDEPENDENCE DATA

Symbol	Mutant locus	Linkage group	Recombination percentage	Standard error
c	Albino	I	50·2	2·6
p	Pink-eye	I	52·4	7·7
d	Dilute	II	45·4	3·7
s	Piebald	III	52·9	4·5
lx	Hemimelia tibiæ (luxate)	III	55·3	6·1
a	Non-agouti	V	51·6	2·3
Sd	Danforth's short-tail	V	58·5	6·2
bl	Belted	VI	48·9	2·9
Ca	Caracul	VI	51·3	5·7
N	Hypotrichosis hypokeratotica (naked)	VI	55·0	6·4
Re	Rex	VII	53·0	5·7
sh-2	Shaker-2	VII	41·1	9·8
wa-2	Waved-2	VII	59·3	9·2
b	Brown	VIII	47·4	2·5
T	Brachyury	IX	56·4	4·8
v	Waltzer	X	46·7	6·8
Miw	White	XI	47·6	6·4
je	Jerker	XII	45·5	6·2
ru	Ruby eye	XII	40·4	7·4
fz	Fuzzy	XIII	55·4	6·3
ln	Leaden	XIII	47·5	4·8
—	Sex		47·3	2·0
Va	Varitint-waddler		45·3	6·9

any other mutant locus. Crinkled and flexed thus appear to constitute a new linkage group which has been given the Roman numeral XIV.

I am indebted to Dr. D. S. Falconer for helpful advice and to Prof. C. H. Waddington for facilities kindly made available at the Institute of Animal Genetics.

J. W. B. KING

Agricultural Research Council
Animal Breeding Research Organisation,
Glenbourne,
South Oswald Road,
Edinburgh 9.

Aug. 11.

[1] Falconer, D. S., Fraser, A. S., and King, J. W. B., *J. Genet.*, **50**, 324 (1951).
[2] Hunt, H. R., Mixter, R., and Permar, D., *Genetics*, **18**, 335 (1933).
[3] Grüneberg, H., "The Genetics of the Mouse" (Nijhoff, The Hague, 1952).
[4] Fisher, R. A., "The Design of Experiments" (Oliver and Boyd, Edinburgh, 1949).
[5] Carter, T. C., and Falconer, D. S., *J. Genet.*, **50**, 307 (1951).
[6] Carter, T. C., and Falconer, D. S., *J. Genet.*, **50**, 399 (1952).

A Rare Estuarine Copepod Crustacean, *Enhydrosoma garienis*, found in the Holocene of Kent

AMONG some small organisms including a single ostracod shell, washed from a sample of clay brought to me for identification by Dr. W. A. Macfadyen, was a small tapering object about ¼ mm. long, terminating in a fine seta. The silty clay, penetrated by fine contemporary rootlets, had been collected from 6 in. below a Neolithic floor by Mr. J. P. T. Burchell at Lower Halstow, Kent. The object, when examined under the microscope, was seen to be a copepod complete with furcal rami and at least some of its appendages. As a zoologist, knowing how difficult it is to sort out these minute crustacea from a few drops of mud and water, I was surprised that anyone could have found so small a specimen in a pound of dried clay and mounted it with gum tragacanth intact on a black cardboard microscope slide.

The minute size of the specimen is indicated in Fig. 1 by comparing it with a fragment of the 'dust' from an electric shaver. Copepods are delicate

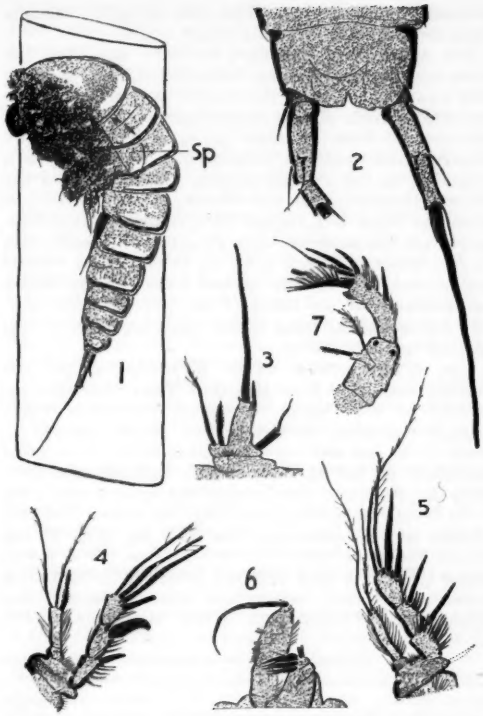


Fig. 1. *Enhydrosoma garienis* Gurney (male). 1, The intact specimen after relaxing and clearing. (*sp.*) spermatophore: outline drawn to the same scale of one day's growth of a human hair on a male chin (× *c.* 140); 2, dorsal view of the last segment of the abdomen and furcal rami; 3, the fifth leg; 4, the third leg; 5, the second leg; 6, second maxilla and maxillipede; 7, second antenna (Figs. 2–7 × *c.* 410)

organisms living in water, and contract and shrivel so badly on drying that no zoologist would think that a recent specimen mounted on card would be worth looking at. Dr. Macfadyen's skill in finding and preserving so small and delicate an object, presumably thousands of years old, however, goaded me into investigating the specimen further.

After being soaked off the black card the object was boiled in a 2 per cent solution of tribasic sodium phosphate in order to soften and relax it. This treatment is recommended by Harley and Ross[1] for reclaiming dried arthropods and nematodes. The specimen was then cleared in lactic acid and some of the debris still adhering to it was removed with needles. The appearance of the specimen is shown in Fig. 1, which is drawn from a photograph taken at that time. The copepod was evidently a male as not only could a swollen first antenna be seen among the extraneous matter still covering most of the appendages but inside the animal could quite easily be seen the chitinous walls of a spermatophore (*sp.*). The fifth leg was still intact and the furcal rami with their setæ practically complete (Fig. 2).

Up to this time, I had thought that the specimen was probably a well-known British freshwater species which had somehow reached the clay. The rather unusual shape of the furcal rami, however, showed at once that it was not to be found in Gurney's monograph[2], nor in Sar's[3], which includes most likely marine species as well. Further progress could only

be made by dissection. This was achieved using a Labgear–Harding microdissector[4].

The animal was dissected in lactic acid and the parts mounted in polyvinyl lactophenol, after staining with lignin pink. With the exception of the mandible and first maxilla all the appendages on both sides of the animal, that is, nine pairs, were successfully removed and mounted permanently on a slide, now preserved in the Palæontological Department of the British Museum (Natural History). A selection is shown in Figs. 3–7. Apart from some of their tips, nearly all the setæ are still intact. The outer seta on the basis of leg 2 (Fig. 5) is shown in dotted outline only, as it was absent from the leg drawn but present on its fellow from the opposite side. The corresponding setæ of the third leg (Fig. 4) was missing on both sides.

The species proves to be *Enhydrosoma garienis* Gurney[5] described from Breydon Water, Norfolk, the estuary of the Rivers Yare and Waveney, which Gurney describes as subject to great changes in salinity. It has not been recorded since its original discovery, so far as I am aware, and the specimen from the Holocene clay is only the second male ever to be found, as Gurney had only one male. The prehensile first antenna and the fifth leg (Fig. 3) are almost identical with Gurney's figures. The furcal ramus (Fig. 2) is very different from the furcal ramus drawn by Gurney, which was from a female, but agrees with his description of that of the male. The third leg of the male is also figured for the first time here (Fig. 4).

E. garienis is the only species of the genus which is not completely marine in habitat, so that for an understanding of the earlier conditions of the Neolithic site it is fortunate that Gurney found and described his few specimens of this, the only estuarine species.

I must express my thanks to Dr. Macfadyen for giving me the specimen to investigate.

J. P. Harding

British Museum (Natural History),
London, S.W.7.
Aug. 7.

[1] Harley, J. van C., and Ross, J. A., *Science*, **105**, 318 (1947).
[2] Gurney, R., "Brit. Fresh-water Copepoda", 3 vols. (Ray Soc., 1930–33).
[3] Sars, G. O., "Crustacea of Norway: Copepoda", 5 vols. (1903–21).
[4] Harding, J. P., and Washtell, C. C. H., *J. Quek. Micro. Club* (4), **3**, 89 (1950).
[5] Gurney, R., *Zool. Anz.*, **87**, 321 (1930).

Flowering Responses of Some Palestinian Legumes to Photoperiod and Temperature

A late autumn outdoor sowing was made of eighteen species of wild-growing leguminous annuals. As soon as the seedlings were big enough to handle, they were potted and grown under fixed photoperiods of 9, 12, 15 and 18 hr., and at natural day-length, in a heated greenhouse in which the temperature was thermostatically maintained above 14° C. A parallel outdoor control series, comprising the genera represented by more than one species, was exposed to lower average temperatures, with minima frequently amounting to only a few degrees above zero. Each treatment lot consisted of five replications. The natural day-length diminished during the experimental period from 11 hr. 15 min. to the annual minimum of 10 hr. 25 min., and then went up again to just under 12 hr. by the time all flowering was over on the greenhouse plants. Observations on the outdoor plants were continued until May 1, when the length of day was 13 hr. 25 min.

The photoperiodic treatments have been tabulated in the order of increasing time-interval from germination to flowering (Table 1). Individual treatment means have been omitted, and photoperiodic indications have been bracketed into statistically homogeneous groups, each group being furnished with the estimate of its mean. Non-homogeneous groups differ significantly at the 5 per cent level.

Table 1. Number of Days from Germination to the Onset of Flowering under Different Photoperiodic Treatments

Species	Homogeneous groups	Estimates of means with confidence limits
Trigonella spinosa L.	(15, 18, 12, 9, N*)	81·6 ± 5·0
T. monspeliaca L.	(18, 15); (12, N); (9)	89·5 ± 7·9; 98·5 ± 7·9; 113·0 ± 11·1
T. coelesyriaca Boiss.	(18); (15, 12, 9); (N)	80·0 ± 11·1; 90·7 ± 6·4; 98·0 ± 11·1
Medicago orbicularis (L.) Bartal.	(15, 18); (12); (9, N)	75·5 ± 7·9; 83·0 ± 11·1; 95·5 ± 7·9
M. coronata Desr.	(15); (12, 18, N); (9)	65·0 ± 11·1; 73·7 ± 6·4; 83·0 ± 11·1
Melilotus sulcatus Desf.	(18, 15, N); (12, 9)	89·3 ± 6·4; 104·0 ± 7·9
Trifolium lappaceum L.	(18, 15); (12, N); (9)	82·5 ± 7·9; 110·5 ± 7·9; 128·0 ± 11·1
T. stellatum L.	(18, 15, N); (12, 9)	83·7 ± 6·4; 106·0 ± 7·9
T. purpureum Loisel.	(18); (15, N, 12, 9)	85·0 ± 11·1; 105·5 ± 5·6
T. palaestinum Boiss.	(18, 15); (N, 12, 9)	96·5 ± 7·9; 116·7 ± 6·4
T. scabrum L.	(18, 15); (N, 12); (9)	65·5 ± 7·9; 90·0 ± 7·9; 103·0 ± 11·1
T. vavilovii Eig.	(18, N); (15); (12, 9)	64·0 ± 7·9; 81·0 ± 11·1; 104·0 ± 7·9
T. spumosum L.	(18, 15, N); (12, 9)	73·0 ± 6·4; 100·5 ± 7·9
T. zerocephalum Fenzl.	(18, 15, N); (12); (9)	71·0 ± 6·4; 92·0 ± 11·1; 109·0 ± 11·1
Lotus peregrinus L.	(18, 15, 12, N, 9)	93·2 ± 5·0
Tetragonolobus palaestinus Boiss.	(15, 18, 12); (N); (9)	85·0 ± 6·4; 98·0 ± 11·1; 108·0 ± 11·1
Astragalus hamosus L.	(18, 15); (12); (N, 9)	97·5 ± 7·9; 103·0 ± 11·1; 114·0 ± 7·9
Vicia narbonensis L.	(18, 15, 12, N); (9)	63·2 ± 5·6; 111·0 ± 11·1

* Natural day-length.

The fact that, however tardily, flowering sets in eventually even under the 9-hr. photoperiod and the absence of a photoperiodic threshold defy any traditional photoperiodic classification. It seems that these legumes would be most appropriately classified, according to Chouard[1], as "plantes héméropériodiques préférantes", with *Medicago* possibly fitting in better with this author's "plantes eurypériodiques". It is noteworthy that in the case of *Melilotus sulcatus* and some species of *Trifolium*, the natural day-length, which did not quite attain 12 hr. in the greenhouse series, significantly advanced flowering as compared with the 12-hr. photoperiod. The gradual lengthening of the day apparently exerts a stimulating effect, as distinct from the effect of static photoperiodic values.

On the assumption that the difference in temperature-levels constitutes by far the most essential difference between the outdoor series and the greenhouse natural day-length control, the differences in the number of days from germination to the onset

Table 2. Effect of Temperature on Flowering at Natural Day-length

Species	No. of days from germination to flowering: High temperature	Low temperature
Trigonella spinosa	91	160
T. monspeliaca	100	153
T. coelesyriaca	98	154
Medicago orbicularis	97	158
M. coronata	79	140
Trifolium lappaceum	112	154
T. stellatum	88	170
T. purpureum	98	171
T. palaestinum	114	168
T. scabrum	84	170
T. varilovii	65	156
T. spumosum	80	161
T. zerocephalum	74	158

L.s.d. for temperature effect at $P = 0{\cdot}01$, 50·54.
L.s.d. for temperature effect at $P = 0{\cdot}05$, 36·06.

of flowering (Table 2) can be taken as an indication of the effect of temperature on flower induction.

It appears that in all the species tested, flowering is considerably hastened by high temperature. This response is somewhat at variance with that recorded for related pasture legumes[2] and actually indicates a behaviour diametrically opposed to that attributed to certain species of *Trifolium* and *Medicago*[3].

It is rather interesting that the species investigated, all of which flower in the early spring in a region of a relatively short day, respond readily to such long photoperiods as 15 or even 18 hr., which can be assumed to be entirely outside the scope of their evolutionary experience. It is obvious that, in the absence of a critical threshold, a purely quantitative response to day-length does not in itself constitute the flower-inducing mechanism. The time of flowering would appear to be determined by an interplay of photoperiod and temperature. The gradually increasing day-length coupled with rising temperature in the spring evidently induces flowering when a suitable combination of the two complementary factors is reached.

I thank Mr. S. Zacks for assistance in the carrying out of statistical computations. A fuller account of this investigation, including additional information on the growth and development of the experimental plants, will be published elsewhere.

N. Landau

Research Council of Israel,
P.O. Box 5192,
Jerusalem.
June 19.

[1] Chouard, P., Rep. 13th Int. Hort. Congr., **2**, 820 (1952).
[2] Roberts, R. H., and Struckmeyer, B. E., *J. Agric. Res.*, **59**, 699 (1939). Ludwig, R. A., *et al.*, *Canad. J. Agric. Sci.*, **33**, 274 (1953).
[3] Aitken, Y., *Aust. J. Agric. Res.*, **6**, 212 and 258 (1955).

Anthracnose Fungi of Olives

In published reports on anthracnose disease of olives, mention is made of only one responsible organism, the fungus described by Almeida[1] as *Gloeosporium olivarum*. I have observed that the causal organism of olive anthracnose in South Africa differs greatly from European and American isolates in spore morphology and cultural characteristics. The spores from Portuguese and South African isolates are much narrower than those isolated in Italy and the United States. The South African fungus develops a pink pigment in the mycelium on potato dextrose agar, as does the Japanese[2] fungus; but isolates from Portugal, Italy and the United States have a grey to olive-green mycelium. The spores from the Italian isolates agree very closely with those of *Colletotrichum gloeosporioides* Penz., and as Ciccarone[3] observed setæ in the fungus from olives it is very likely that the two are identical. Spores from a Californian[4] isolate showed close agreement with the spores of *Glomerella cingulata* (Stonem.) Spauld. and v. Schrenk; they are as broad as, but decidedly shorter than, those of *Colletotrichum gloeosporioides*. The Italian and American isolates differ from the Portuguese and South African forms also in the method by which the conidia are produced. The latter fungi are characterized by the formation of abundant microspores on the mycelium, which are much smaller than the spores formed in the acervuli; in the former, spores are only sparingly formed on the mycelium and they are of about the same size as the acervular spores.

Such wide variation in spore size and cultural features raises doubt whether all the anthracnose fungi of the olive should be regarded as *Gloeosporium olivarum* Alm. In my opinion, they should not, for I found that the South African fungus was morphologically and culturally indistinguishable from the chromogenic strain of *Glomerella cingulata* that Dr. M. C. Goldworthy of Beltsville, United States, isolated from apples[5]. The South African fungus could even produce a rapid fruit rot when inoculated into apples. Another reason for considering the South African fungus as distinct from *Gloeosporium olivarum* Alm. is that the former can cause a blossom blight, which has never been reported as a feature of the olive disease in Portugal. The South African fungus is therefore considered identical with Goldworthy's chromogenic strain of *Glomerella cingulata*. However, in respect of spore size and method of spore formation this strain is much more closely related to *Gloeosporium olivarum* than to most other strains of *Glomerella cingulata*. It is felt that this should be expressed in the name.

It is known that *Glomerella cingulata* is extremely variable. Its strains can, however, be grouped in seven different types, two of which have not been known to produce perithecia[6]. Both conidial types (one is the pink chromogenic strain) possess the slender spores which are so typical of the non-perithecia-forming *Gloeosporium olivarum* Alm. Hence it is thought that the slender-spored conidial strains of *Glomerella cingulata* should not be included in this species; but rather that Edgerton[7] should be followed in distinguishing between non-perithecia-forming and perithecia-forming strains of *Glomerella cingulata* and identifying the first with the name *Gloeosporium fructigenum* Berk. The chromogenic strain of *Glomerella cingulata* could then be conveniently called *Gloeosporium fructigenum* Berk. f. *chromogenum* Gorter form. nov. (= Goldworthy's chromogenic strain of *Glomerella cingulata* (Stoneman) Spauld. and v. Schrenk *loc. cit.*[5]) which apparently not only causes an anthracnose of apples and olives but also of peaches[8]. To bring out the close relationship which exists between *Gloeosporium fructigenum* Berk. f. *chromogenum* and *Gloeosporium olivarum* Alm. from Portugal (cross-inoculations on apple are also possible), the latter should be renamed *Gloeosporium fructigenum* Berk. f. *olivarum* (Alm.) Gorter comb. nov. (= *Gloeosporium olivarum* Almeida *loc. cit.*[1]).

The presentation of this preliminary communication seems desirable as this is the first time that more than one anthracnose fungus has been identified on olives.

The implication is that caution should be exercised in ascribing anthracnose of olives to *G. olivarum* Alm.

G. J. M. A. Gorter

Department of Agriculture,
Pretoria.
Aug. 6.

[1] Almeida, J. V. d', *Bull. Soc. Myc. France*, **15**, 90 (1899).
[2] Hemmi, T., and Kurata, S., *J. Soc. Trop. Agric. Taiwan*, **6**, 573 (1935).
[3] Ciccarone, A., *Boll. del Staz. di Pat. Veg.*, **5**, Serie 5, 143 (1947).
[4] Pontis, R. E., and Hansen, H. N., *Phytopath.*, **32**, 642 (1942).
[5] Andes, J. O., and Keitt, G. W., *Phytopath.*, **40**, 915 (1950).
[6] Strubble, F. B., and Keitt, G. W., *Amer. J. Bot.*, **37**, 563 (1950).
[7] Edgerton, C. W., *Phytopath.*, **5**, 247 (1915).
[8] Ramsey, G. B., Smith, M. A., and Heiberg, B. C., *Phytopath.*, **41**, 447 (1951).

Ætiology of European Foul Brood ; a Disease of the Larval Honey-bee

The cause of European foul brood was originally thought to be *Bacillus alvei*[1] or a mixture of *B. alvei* and *Streptococcus apis*[2]. The causative organism was later named and described by White[3] as *Bacillus pluton*, a lanceolate Gram-positive bacterium. This organism is the first of several which have been found to appear in diseased larvæ. However, White and others failed to culture *B. pluton in vitro* and it was afterwards considered to be a dissociant form of *Bacillus alvei*[4], of *Bacterium eurydice*[5], or of both[6]. Others[7,8] have maintained that *B. pluton* is a separate organism. It has been pointed out that *Streptococcus pluton* would be a more suitable designation than *Bacillus pluton* both on morphological grounds and in the absence of evidence that it forms spores. For these reasons and those given below the organism will be referred to as *Streptococcus pluton*.

Attempts have recently been made, by Prof. L. P. Garrod (St. Bartholomew's Hospital), to cultivate *S. pluton*, from diseased larvæ[9]. A Gram-positive encapsulated, pleomorphic, usually oval coccus which grew in anaerobic conditions on glucose–broth agar, was repeatedly isolated from diseased larvæ. Some evidence was obtained on one occasion that this bacterium grew in honey-bee larvæ and developed into an organism morphologically identical with *S. pluton*, but the disease failed to develop in this and in repeated experiments.

During further attempts to re-isolate the organism on special media, I have recently been able to isolate a bacterium which is probably the same as that previously isolated by Garrod ; but its growth is relatively much stronger, and it is now morphologically stable. It appears to be *S. pluton*. The organism can readily be isolated in anaerobic conditions on a medium composed of : 1 per cent yeast extract ('Difco' yeast extract is very suitable) ; 1 per cent glucose ; 0·1 molar potassium dihydrogen phosphate ; 2 per cent agar. Adjust to *p*H 6·5 with concentrated potassium hydroxide. Sterilize by steaming or in the autoclave at 5-lb. pressure (108° C.).

The optimum temperature for growth is about 35° C. The optimum *p*H is about 6·5 ; no growth occurs at or below *p*H 5·5. The colonies are small (never more than about 1·5 mm. in diameter), round, entire and convex. They are transparent and microscopic after 24 hr., just visible and granular after 48 hr., and become very granular and pearly white by reflected light and almost opaque and slightly brown by transmitted light after three days. The organism grows as a lanceolate *Streptococcus* in chains of variable lengths. It has a thick cell wall, is highly refractile in watery suspension and is Gram-positive. Carbohydrate is essential ; but only glucose, fructose or, to a lesser extent, sucrose support growth. Neither acid nor carbon dioxide is formed in detectable amounts. Citrate strongly inhibits growth and can be counteracted by magnesium. Marked inhibition of growth is caused if the ratio $[Na^+]/[K^+]$ is greater than 1 ; virtually no growth occurs if K^+ is entirely replaced (apart from the normal traces in the constituents of the medium) by Na^+. Carbon dioxide stimulates growth. Oxygen is normally tolerated up to a concentration of about 1 per cent ; but growth is then weak and apparently involuted with individual cocci poorly differentiated to give chains with a more rod-like appearance.

Invariably, with the numerous isolates made so far of *S. pluton*, there have appeared colonies of *Bacterium eurydice*. The colonies of the latter have always been the first to appear, and its cultural characteristics agree with those given in detail by Gubler[8]. The two organisms will readily subculture together in mixed culture in anaerobic conditions on the medium described above. These mixed cultures (fifth subcultures) have repeatedly produced acute and extensive European foul brood when sprayed on the combs of brood in healthy bee colonies. The two organisms have always been re-isolated from the diseased larvæ of these colonies. Virulence seems to diminish markedly in subculture.

B. eurydice alone does not cause the disease, as previous workers have also shown. *S. pluton* in pure culture also has not usually caused the disease ; the bacteria have appeared to grow vigorously in young larvæ but have disappeared in older larvæ after producing forms suggestive of the involuted types obtained in culture in relatively high oxygen tensions. On a few occasions an initially mild attack of the disease affecting very few larvæ has arisen after infection with pure cultures of *S. pluton*. However, *B. eurydice* was also seen to be present in the diseased larvæ and was always isolated, as usual, with *S. pluton*.

No evidence has been obtained to support the theory[5] that *B. eurydice* dissociates into *S. pluton* ; but it seems that the presence of both bacteria is necessary for the disease to appear. The appearance of *B. eurydice* in those larva which have shown disease after infection with pure cultures of *S. pluton* suggests that it was already present in the bees. This supports the findings of Burri[5] and Gubler[8] that *B. eurydice* can occur in colonies of healthy bees. However, its occurrence does not appear to be widespread ; at least not in the locality where the experiments reported here were carried out.

Further work on the symbiotic relationships between *B. eurydice* and *S. pluton* and upon the epidemiology and control of the disease is in progress and will be reported in more detail in due course.

L. Bailey

Rothamsted Experimental Station,
Harpenden, Herts.
Aug. 13.

[1] Cheshire, F. R., and Cheyne, W. W., *J. Roy. Micro. Soc.*, **5**, 581 (1885).
[2] Maassen, A., *Arb. Biol. Abt. (Anst.-Reichsanst.) Berl.*, **6**, 53 (1908).
[3] White, G. F., Bull. U.S. Bur. Ent., No. 157 (1912).
[4] Lochhead, A. G., *Sci. Agric.*, **9**, 80 (1928).
[5] Burri, R., *Beih. Schweiz. Bienenztg.*, **1**, 209 (1943).
[6] Burnside, C. E., *J. Econ. Ent.*, **27**, 656 (1934).
[7] Tarr, H. L. A., *Ann. App. Biol.*, **25**, 815 (1938).
[8] Gubler, H. U., *Schweiz. Z. Allg. Path.*, **17**, 507 (1954).
[9] Rep. Rothamsted Exp. Sta., 136. (1954).

Intrafollicular Cleavage of Human Ovum

In studies extending over the past four years on more than four hundred human follicular and tubal ova[1], three ova were found to have undergone cleavage *in vivo* within the intact follicle, without any possible contact with spermatozoa. There was no evidence of any abnormal stimulation.

Follicular ova were obtained from ovaries *in situ* or immediately after their removal from patients undergoing gynæcological surgery. The unruptured follicles were grossly normal in appearance and ranged in size from 3 to 16 mm. in diameter. Aspiration of the follicles was accomplished with a sterile syringe and 20-gauge needle. The needle was inserted into the ovarian tissue 3–4 mm. away from the edge of the follicle and then passed into its antrum so as to enter through the base, hence obviating any leakage of the follicular fluid. All normal-appearing follicles were likewise aspirated in succession with the same syringe and needle, thus pooling the ova from a given ovary. The fluid was then taken immediately to the laboratory and expressed as a drop on a glass slide. A petrolatum ring was made around the drop and a cover-glass placed so that it touched the fluid but without direct pressure upon the ova. In order to have a petrolatum ring of uniform thickness, the petrolatum was expressed from a syringe through an 18-gauge needle without bevel. The ova were then studied by means of phase-contrast microscopy and photographed in phase contrast.

The ova which had undergone cleavage in the clear, straw-coloured follicular fluid included a 2-cell stage with two polar bodies within an intact zona pellucida, a 4-cell stage with three polar bodies within an intact zona pellucida, and the blastula depicted in Fig. 1. The zona pellucida, completely denuded of the corona radiata and cumulus cells, surrounds a blastula of approximately fifty cells. The exact number could not be ascertained because of the difficulty in counting the cells in different focal levels in phase contrast. The cells, which differ in size partly because of asynchronous cell division, surround the segmentation cavity. Granules may be noted in the zona pellucida.

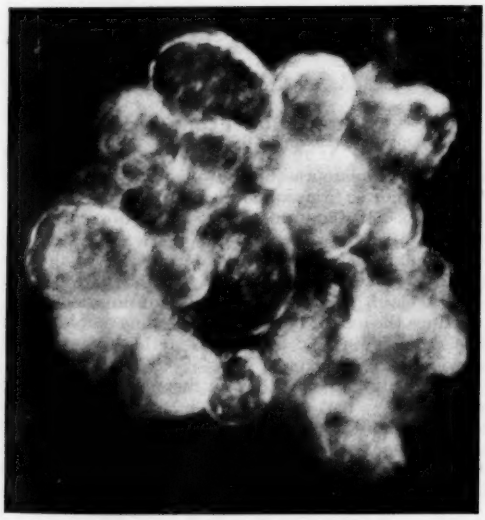


Fig. 1. Blastula stage of human ovum aspirated from intact ovarian follicle. (× *c.* 66)

The diameter of the blastula, to the outer surface of the zona pellucida, measured 150 microns.

In that ova from the different follicles were pooled, the exact size of the follicle which contained the blastula is not known. The specimen was obtained during the last half of the menstrual cycle. In comparison with normal human ova fertilized *in vivo* and recovered at pre-implantation stages of development[2], this blastula is approximately four days old.

The extremely rare occurrence of primary ovarian pregnancy in the human conceivably represents intrafollicular development of an ovum. From tissue properly prepared in such cases the haploid or diploid chromosomal content could be investigated. A study concerning the presence or absence of the sex chromatin body in the cells of a primary ovarian conceptus might aid in elucidating the origin of this type of gestation.

Continuing efforts are being made to record other intrafollicular developmental stages of the human ovum. Ascertainment of the chromosomal content is planned for any subsequent specimens.

Landrum B. Shettles
Department of Obstetrics and Gynecology,
College of Physicians and Surgeons,
and the Sloane Hospital for Women,
New York City.
Aug. 8.

[1] Shettles, L. B., *Fed. Proc.*, **12**, 131 (1953); *Amer. J. Obstet. and Gynecol.*, **66**, 235 (1953); *Excerpta Medica*, **7**, 320 (1954); "Tendances actuelle en gynécologie et obstetrique" (S. A. Georg et Cie., Genève, 1955); Exposition scientifique congrès international de gynécologie et d'obstétrique, Genève (1954); *Amer. J. Obstet. and Gynecol.*, **69**, 365 (1955); *Sloane Hospital Bull.*, **1**, 12 (1955); *Bull. New York Acad. Med.*, **31**, 153 (1955); *Trans. New York Acad. Sci.*, **17**, 99 (1955); *Fert. and Sterility*, **6**, 287 (1955).

[2] Hertig, A. T., Rock, J., Adams, C., and Mulligan, W. J., *Contrib. Embryol.*, **35**, 199 (1954).

Filaments of Silica

In the course of experiments with oxide compounds containing silica, fired in a wire-wound alumina tube furnace in a reducing atmosphere, filamentous deposits were formed.

On examination, they proved to be silica in the form of filaments of varying diameter, some of which were of approximately molecular dimensions. A typical electron microscope photograph is shown in Fig. 1. The filaments exhibited strong electrostatic charges and they would be attracted, from a distance of 1–1½ cm., to any material, organic or inorganic. The

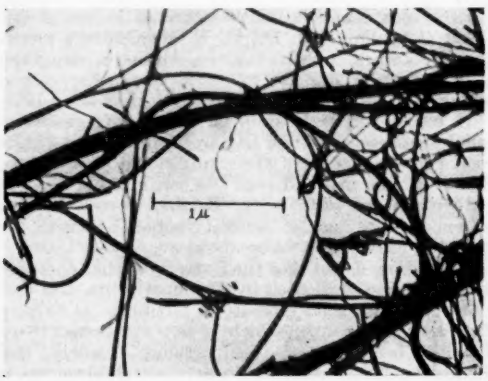


Fig. 1

charges decayed slowly and could not be detected six months later.

B. E. Vassiliou
The British Ceramic Research Association,
Queens Road,
Penkhull, Stoke-on-Trent.
July 13.

Use of Plastic Tubing in Chromatography

During a chromatographic separation of the carotenoid pigments of the starfish *Marthasterias glacialis* (L.) from Madeira, it was found that some pigment disappeared during elution, which was necessarily prolonged in order satisfactorily to separate the relatively large number of pigments present in the total carotenoid extract. Several pigments were lost in this way (presumably owing to oxidation on the column), and further, some of the zones were so small as to make it difficult to isolate them by extruding the column.

These difficulties were largely overcome by using a chromatographic column made in a tube of polyvinyl chloride instead of glass. This plastic is transparent, and during the time of chromatographic separation does not appear to react with the solvents used, such as light petroleum, diethyl ether, ethanol and methanol. The chief advantage of this type of column is that it may be cut easily and quickly with a razor as soon as the bands become distinct, thereby lessening much of the elution and consequent loss of pigment.

When adsorbents, added in a slurry, tend to adhere to the sides of the tube, they can easily be dislodged by tapping the flexible plastic.

By using such tubes, it was possible to isolate eight carotenoids from the aboral integument of this starfish.

H. G. Vevers
Zoological Society of London,
Regent's Park,
London, N.W.1.

N. Millott
Department of Zoology,
Bedford College,
Regent's Park,
London, N.W.1. July 10.

Causes of Eskimo Birth-rate Increase

In a recent article on "Researches in the Arctic Ocean"[1] dealing with Dr. G. E. MacGinitie's recent zoological work at Point Barrow, Alaska, a paragraph is of particular interest to me as an anthropologist who has spent time, off and on, at Barrow since 1908.

It reads: "The Eskimo birth-rate is increased as much as threefold when the arctic people eat 'white man's food' instead of their traditional pure animal diet of whale, fish and seal. When hunting was the only means of subsistence, Eskimo women became pregnant only once in several years; but with the new diet they bear a baby about every year".

There is no doubt that the Barrow diet has changed, along the lines indicated by Dr. MacGinitie, and that there has been such increase of birth-rate as he says. But another change, which is not mentioned there, has also been suggested as pertinent, namely, that Eskimo mothers used to nurse their children up to ages of three and four years; while now, under white tutelage, they nurse them for only about as many months.

When I was first at Barrow, forty-eight years ago, there was in residence for the Presbyterian Church a medical missionary, Dr. H. R. Marsh, who was then on his second assignment, having been there several years before going out on a leave which he spent at medical schools. Dr. Marsh stated the facts about as Dr. MacGinitie does; but his explanation was different: That women do not readily conceive while they nurse their babies; and he believed the previously normal three-year spacing of births had been reduced to a yearly one chiefly through the adoption of the white man's style of early weaning.

While my observation as to the usual three-year spacing agrees with those of Dr. MacGinitie and Dr. Marsh, I noted many exceptions to that rule during the eleven years I spent with Alaskan and Canadian Eskimos. The most striking case was that of an inland couple who looked to me around forty. They told me they were the parents of eleven children, none of whom had been twins; nine of these were still living, they said, the other two having died at or soon after birth. When I learned this, my chief interest was in the size of the family. It was the largest that anybody had heard of; and, engrossed with this, I neglected inquiring about spacing. Since these were 'uncivilized' people, there is no doubt the mother nursed each child until the next came; and she may have nursed her previous along with the current baby, as I often saw done. Neither is there any doubt that these parents of eleven had produced them while living on Dr. MacGinitie's traditional pure animal diet (which was never strictly pure in northern Alaska after 1880).

Perhaps both Dr. MacGinitie and Dr. Marsh are partly in the right. Moreover, perhaps other factors than change in eating and nursing habits should be invoked to help explain the undoubtedly higher birth-rate; for many and profound have been the changes at Barrow since Dr. John Simpson first described these Eskimos a century ago.

Vilhjalmur Stefansson
Dartmouth College,
Hanover,
New Hampshire. July 30.

[1] *Nature*, 177, 1215 (1956).

"Automation Economics"

Mr. Austen Albu's reply to my protest against having been misrepresented in his review of my book "The Economic Consequences of Automation" (October 13, p. 816) contains two further misrepresentations in a single sentence. He attributes to me the view that "all steps taken to increase production are inflationary"; and states that on p. 84 of my book I claim that "the effect of automation is ... to reduce the extent of inflation". I must emphatically disclaim having held or expressed these views, both of which are incorrect.

What I did say was that an increase of production is inflationary if it means an increase in the *aggregate* cost of production. In quoting me as having said that automation reduces the effect of inflation, Mr. Albu omitted my all-important reservation "other things being equal".

Paul Einzig
120 Clifford's Inn,
London, E.C.4.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 19

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. A. O. Chesters: "The Approach to 'Science for Young Children'".* (Seventh of eight lectures on "Problems of the Junior School". Further lecture on November 26.)

Tuesday, November 20

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. J. S. Wilkie: "Mendel and Galton: Founders of the Scientific Study of Heredity".*

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. J. A. Banks: "Ailt-na-Lairige Prestressed Concrete Dam".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Data Processing Equipment for Experimental Work; a Review of Techniques and Methods", opened by Dr. M. V. Wilkes.

Tuesday, November 20—Wednesday, November 21

INSTITUTION OF GAS ENGINEERS (at Church House, Westminster, London, S.W.1)—22nd Autumn Research Meeting.

Wednesday, November 21

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. V. Wynn: "Salt and Water Metabolism".*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. Dickson Wright: "Quacks Through the Ages".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. G. D. Nicholls: "Autometasomatism in the Lower Spilites of the Builth Volcanic Series"; Dr. C. D. V. Wilson: "Seismic and Gravity Investigations in the Vale of Clwyd, North Wales".

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (in the Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1), at 5 p.m.—Mr. F. C. Mead: "Some Problems Arising in the Technical Education of P.O. Engineering Staff".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion meeting on "Climatic Change with special reference to the Period of the Instrumental Record".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. T. Barna: "The Replacement Cost of Fixed Assets in British Manufacturing Industry in 1955".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. D. Lacy: "Studies on the Neurones of Patella Vulgata by Light and Electron Microscopy".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion Meeting on "The Micro-Determination of Sulphur".

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting of the MEDICAL and SOCIAL PSYCHOLOGY SECTIONS, at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8.30 p.m.—Symposium on "Anthropological, Psychometric and Psychotherapeutic Aspects of Homosexuality".

Wednesday, November 21—Thursday, November 22

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1)—Autumn General Meeting.

Thursday, November 22

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. W. B. Emery: "Archaic Egypt—Recent Discoveries at Sakkara".*

UNIVERSITY OF LONDON (at Bedford College, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. B. C. King: "Some Problems of Igneous Geology in Southern Africa".*

CHADWICK TRUST (at the Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 5.30 p.m.—Dr. P. A. Raffle: "The Health of the Worker"* (Chadwick Public Lecture).

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. F. W. Gifford and Mr. A. M. Janhunen: "The Design and Construction for the Prestressed Concrete Hangars at Helsinki".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Presentation and Demonstration of the Theory of Semi-Conductors to Students of Electrical Engineering", opened by Mr. P. Godfrey.

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Birdcage Walk, London, S.W.1), at 6 p.m.—Mr. L. P. Coombes: "Aeronautical Development in Australia and Its Potential Value to the British Commonwealth" (Twelfth British Commonwealth and Empire Lecture).

Thursday, November 22—Friday, November 23

BRITISH NUCLEAR ENERGY CONFERENCE (at the Central Hall, Westminster, London, S.W.1), at 10 a.m. daily—Symposium on "The Calder Works Nuclear Power Plant".

Friday, November 23

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. J. R. Whinfield: "New Fibres". (Seventh of ten University Extension Lectures on "Technology and Industry". Further lectures on November 30, December 7 and 14.)

ROYAL AERONAUTICAL SOCIETY, GRADUATES' AND STUDENTS' SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. A. W. Kitchenside: "The Effects of Kinetic Heating on Aircraft Structures".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. R. L. Wain: "Plant Growth and Man-made Molecules".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER (preferably with good academic and research qualifications) IN ORGANIC CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (November 24).

BIOCHEMIST (B.Sc.) AT THE WALLACEVILLE ANIMAL RESEARCH STATION, New Zealand Department of Agriculture, to study trace elements and their relation to disease in farm animals—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. A.3/4/59 (November 30).

RESEARCH FELLOW to investigate certain pharmacological or biochemical aspects of cardio-vascular disease—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 30).

ASSISTANT EXPERIMENTAL OFFICER (with a pass B.Sc. degree or equivalent) IN THE DEPARTMENT OF POTATO GENETICS, for general maintenance of stocks and tests of resistance of tuberous *Solanums*—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (December 1).

ASSISTANT LECTURER IN VETERINARY MEDICINE—The Registrar and Secretary, The University, Bristol (December 1).

LECTURER, Grade II, IN CHEMICAL PATHOLOGY in the Veterinary School—The Registrar and Secretary, The University, Bristol (December 1).

LECTURER (graduate in medicine or science, and postgraduate experience in some branch of physiology) IN PHYSIOLOGY in the Faculty of Medicine, University of Birmingham—The Assistant Registrar, Medical School, Birmingham 15 (December 1).

RESEARCH ASSISTANT (with a B.Sc. honours degree and a knowledge of either magnetic measurements, mineralogy or crystallography) for research into structures and magnetic properties of substances of geomagnetic interest—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (December 1).

LECTURER (preferably with a major interest in heat transfer, and a knowledge of some aspect of nuclear engineering) IN ENGINEERING (MECHANICAL)—The Registrar, The University, Manchester 13, (December 3).

SCIENTISTS (with a good honours degree in engineering or physics and the ability to handle data and to write clear concise reports) IN THE OPERATION RESEARCH GROUP at London Headquarters, to study problems of production and mechanization—The National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting X/463 (December 3).

LECTURER or ASSISTANT LECTURER (preferably with special interests in the chemistry of heterocyclic compounds) IN ORGANIC CHEMISTRY—The Registrar, King's College (University of London), Strand, London, W.C.2 (December 7).

ASSISTANT EXPERIMENTAL OFFICER (graduate with mathematical ability and biological interests) to work on the interpretation of data from horticultural experiments—The Secretary, East Malling Research Station, near Maidstone, Kent (December 8).

LECTURER IN FUEL TECHNOLOGY AND CHEMICAL ENGINEERING—The Registrar, The University, Sheffield (December 8).

DEPUTY PRINCIPAL (with a university degree in forestry or equivalent, together with practical and administrative experience in forestry) OF THE AUSTRALIAN FORESTRY SCHOOL, Canberra, Australia—The Official Secretary, Commonwealth of Australia, Australia House, Strand, London, W.C.2 (Australia, December 13).

SENIOR LECTURER IN PHILOSOPHY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 17).

PLANT BREEDER (with a university honours degree in science or agricultural science and two or more years research experience) WITH THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, to initiate independent studies in the breeding of pasture plants—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 130/292 (December 19).

CHAIR OF CHEMICAL PATHOLOGY—The Registrar, The University, Leeds (December 31).

LECTURER (honours graduate in engineering, with practical experience) IN PETROLEUM PRODUCTION ENGINEERING—The Registrar, The University, Birmingham (January 1).

ASSISTANT LIBRARIAN (preferably science graduate, with either a recognized library qualification or experience in library work) at

the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (January 15).

DIRECTOR (with a good honours degree and considerable research experience in physical or organic chemistry or in technology) of SUGAR RESEARCH, Department of Sugar Chemistry and Technology, Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C.2 (January 15).

ENTOMOLOGIST (with an honours degree in zoology and training in entomology, and preferably with experience in the control of insect pests occurring in the tropics, especially those attacking sugar cane)—The Director, Mauritius Sugar Industry Research Institute, Reduit, Mauritius (January 17).

ASSISTANT, Grade B (preferably with a knowledge of zoology) IN BOTANY—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham.

ASSISTANTS, Grade B (2), TO TEACH PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

BIOCHEMIST or SENIOR BIOCHEMIST TO TAKE CHARGE OF THE ENDOCRINOLOGY LABORATORY concerned with clinical research in the treatment of cancer—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

BIOCHEMIST (with a science degree of a recognized university and special experience in medical biochemistry) IN THE MINISTRY OF HEALTH, Gold Coast Local Civil Service, to take charge of the Biochemistry Division of the Medical Research Institute—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.117/13/042.

BRADFORD DYERS' ASSOCIATION RESEARCH FELLOW (with high qualifications in science) to undertake research in tinctorial chemistry, textile chemistry or an allied subject—The Director of Education, Technical College, Bradford.

ELECTRONICS TECHNICIAN (with keen practical interest in electronics, and theoretical knowledge up to higher national or equivalent) to construct apparatus associated with a 2-million volt electron accelerator and other special electronics equipment for research—The Director, Radiobiology Research Unit, Mount Vernon Hospital, Northwood, Middlesex.

ENTOMOLOGIST (with an honours degree in natural science and specialized training and experience in entomology) IN THE MEDICAL DEPARTMENT, Western Region of Nigeria (H.M. Oversea Civil Service), to advise on, and supervise mosquito control measures in towns and rural areas in the Region, and carry out surveys on distribution and epidemiological importance of other insect vectors of disease—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.117/410/07.

GEOCHEMIST (with a good honours degree in chemistry or equivalent and some experience in inorganic analysis, with special reference to rock and mineral analysis) IN THE GEOLOGICAL SURVEY DEPARTMENT, Government of Tanganyika, for the analysis of rocks, minerals and ores, and the supervision of junior staff in routine analytical work—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/8/09.

HEAD (with a good honours degree and experience in the direction and administration of metallurgical research, either academic or industrial) OF THE METALLURGY DIVISION, for work in London and Sheffield which includes both fundamental and applied research into the general and physical metallurgy of iron and steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "H.M.D.".

LECTURER or SENIOR LECTURER IN MATHEMATICS; and LECTURERS or SENIOR LECTURERS (3) IN PHYSICS AND MECHANICS, at Britannia R.N. College, Dartmouth—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting Ref. No. 4641/56/7.

LECTURER (with special qualifications in physical chemistry and preferably with experience and/or knowledge of spectroscopy and colorimetry) IN CHEMISTRY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

PHYSICAL and INORGANIC CHEMISTS (preferably with H.N.C. (chemistry) or a general degree, or at least H.S.C. (science), Inter. B.Sc. or equivalent), to engage in research on a variety of interesting and novel projects which include the chemistry related to reactors and the chemistry of inorganic and organic phosphors—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 1314/34.

PHYSICIST or ENGINEER (with at least a second-class honours degree or equivalent, and two years' postgraduate experience) for work involving the investigation of engineering problems connected with the deterioration of electrical insulation in service—The Personnel Officer, Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

RESEARCH ASSISTANT (with a good degree in horticulture or botany) for work on the physiology of flowering in carnations—Prof. R. H. Stoughton, Department of Horticulture, The University, Reading.

RESEARCH FELLOW (graduate in physics or engineering) IN THE COMPUTER LABORATORY, for investigations concerned with the input and output equipment of digital computing machines—The Secretary, Birkbeck College, Malet Street, London, W.C.1.

SENIOR LECTURER IN MARKET GARDEN AND GLASSHOUSE CROPS—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex.

SENIOR TECHNICIAN IN THE ZOOLOGY DEPARTMENT, University of London—The Secretary, Royal Holloway College, Englefield Green, Surrey.

SOIL CONSERVATION OFFICERS (under 45, with a university degree involving specialization in soil conservation, or a university degree in agriculture or related subject, with at least two years postgraduate study or experience of soil conservation) in the Gold Coast Local Civil Service, for duties connected with land-use and anti-erosion measures—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/13/04.

TEACHER (with a good degree in physiology, preferably also with experience in pharmacology) IN PHYSIOLOGY in the Department of Biology—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Edinburgh School of Agriculture; Edinburgh and East of Scotland College of Agriculture. Calendar for 1956–1957. Pp. 88. (Edinburgh: Edinburgh School of Agriculture; Edinburgh and East of Scotland College of Agriculture, 1956.) 1*s*. [189

Air Ministry: Meteorological Office. Geophysical Memoirs. No. 95: Wind and Temperature to 50 KM. Over England: Anomalous Sound Propagation Experiments, 1944–45. By R. J. Murgatroyd. Pp. 30. (London: H.M. Stationery Office, 1956.) 5*s*. net. [189

Year Book of the International Council of Scientific Unions, 1956. Pp. ii+84. (London: International Council of Scientific Unions, c/o Royal Society, 1956.) 5*s*. [189

Fulmer Research Institute. Special Report No. 2: Oxidation Resistant Silicon Aluminium Steels. By E. A. Brandes. Pp. 40. (Stoke Poges: Fulmer Research Institute, 1956.) 10*s*. 6*d*. [189

Department of Scientific and Industrial Research. Memoirs of the Geological Survey of Great Britain. Chemical Analyses of Igneous Rocks, Metamorphic Rocks and Minerals, 1931–1954. By Eileen M. Guppy. With Petrographical descriptions by Dr. P. A. Sabine. Pp. v+78. (London: H.M. Stationery Office, 1956.) 10*s*. 6*d*. net. [189

Building Research Station Digest No. 91: The Programming of House-building. Pp. 8. (London: H.M. Stationery Office, 1956.) 3*d*. net. [189

London and Home Counties Regional Advisory Council for Higher Technological Education. Technical Information Services to Commerce and Industry. Pp. 12. (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1956.) 1*s*. [189

Report of the Interdepartmental Committee on Social and Economic Research. Pp. vi+33. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [189

Other Countries

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique, No. 65: Les Savanes Herbeuses de la Région de Mvuazi (Bas-Congo). Par R. Devred. Pp. 115. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1956.) 100 francs. [189

Indian Forest Records (New Series). Entomology. Vol. 8, No. 10: Immature Stages of Indian Coleoptera (26) (Bostrychidae). By Dr. R. N. Mathur. Pp. 233–246. (Delhi: Manager of Publications, 1956.) As. 14; 1*s*. 3*d*. [189

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 139: Application of Gehrhardt's Formula to Abnormally Stocked Deodar Crops in the Himalayas. By G. S. Mathauda. Pp. ii+4. (Delhi: Manager of Publications, 1956.) As. 7; 8*d*. [189

Aligarh Muslim University Publications. (Zoological Series.) On Indian Insect Types. Edited by Prof. M. B. Lirza. 4: The Early Embryology of *Pyrilla perpusilla* Walter (Homoptera), including some Observations on the Later Development. By Dr. Klaus Sander. Pp. ii+62+12 plates. (Aligarh: Aligarh Muslim University, 1956.) Rs. 5. [189

Contributions from the New South Wales National Herbarium. Vol. 2, No. 4: The Cyatheaceae of Australia. By Mary D. Tindale. Pp. ii+327–362+plates 9–15. (Sydney: Government Printer, 1956.) [189

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 37, July 1956: Age Trends in Poliomyelitis. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [189

United States Department of Agriculture. Picture Sheet No. 25: Sweet-potato Weevil. (Revised edition.) Pp. 2. 5 cents. Home and Garden Bulletin No. 46: Insects and Diseases of Vegetables in the Home Garden. By L. B. Reed. Pp. 48. 25 cents. Technical Bulletin No. 1149: Some Effects of Insecticide Spray Accumulations in Soil on Crop Plants. Pp. 36. 15 cents. (Washington, D.C.: Government Printing Office, 1956.) [189

Uganda Protectorate. Annual Report of the Forest Department for the year ended 31st December, 1955. Pp. vi+65. (Entebbe: Government Printer, 1956.) Shs. 3/25. [189

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique, No. 66: Landscape Evolution in the High Ituri, Belgian Congo. By Robert V. Ruhe. Pp. 92 (7 plates). 90 francs. No. 67: Étude Écologique et Phytosociologique de la Forêt à *Brachystegia laurenti*. Par Dr. R. Germain et C. Evrard. Pp. 105+5 planches. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1956.) [189

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada Memoir No. 279: Oldman River Map-Area, Saskatchewan. By Donald A. W. Blake. Pp. v+52 (4 plates). (Ottawa: Queen's Printer, 1955.) 75 cents. [189

A Museum is a Point of View: Bernice P. Bishop Museum Annual Report for 1955. Pp. 46. (Honolulu: Bernice P. Bishop Museum, 1956.) [189

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office